FOURTH FLOOR, 900 HOWE STREET
VANCOUVER, B.C., CANADA V6Z 2N3

IN THE MATTER OF
the Utilities Commission Act,
S.B.C. 1980, c. 60, as amended

and

IN THE MATTER OF
an Application and an Alternative Application
by Pacific Coast Energy Corporation for
an Energy Project Certificate to construct
and operate Natural Gas Pipeline
Transmission Facilities to and on Vancouver Island

INTERIM REPORT - PHASES I & II

March 14, 1989

Before:

J.G. McIntyre, Chairman
N. Martin, Commissioner
F.C. Leighton, Commissioner

BRITISH COLUMBIA UTILITIES COMMISSION

March 14, 1989

To The Lieutenant Governor in Council

MAY IT PLEASE YOUR HONOUR :

We, the Division of the Commission responsible for the review of an Application for an Energy Project Certificate for the supply of natural gas to and on Vancouver Island have the honour to submit our interim report and recommendations arising out of Phases I and II of our hearing.

Our report is responsive to the Terms of Reference set forth in Ministerial Orders of The Honourable Jack Davis, Minister of Energy, Mines and Petroleum Resources, with the concurrence of The Honourable W. Bruce Strachan, Minister responsible for Environment, dated December 20, 1988 as amended February 24, 1989.

Respectfully,

BRITISH COLUMBIA UTILITIES COMMISSION

JOHN G. McINTYRE, Chairman

NORRIS MARTIN, Commissioner

FRANK C. LEIGHTON, Commissioner

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W-1363

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ABBREVIATIONS

BCFWB	B.C. Fish and Wildlife Branch
BC Gas	B.C. Gas Inc.
B.C. Hydro	British Columbia Hydro and Power Authority
BCWF	B.C. Wildlife Federation
COFI	Council of Forest Industries
the Commission	British Columbia Utilities Commission
DFO	Department of Fisheries and Oceans
EARP	Environmental Assessment and Review Process
EMR	Department of Energy, Mines and Resources
EPC	Energy Project Certificate
EPP	Environmental Protection Plan
ERCB	Energy Resources Conservation Board
GVWD	Greater Vancouver Water District
GVicWD	Greater Victoria Water District
ICG	ICG Utilities (British Columbia) Ltd.
LDC	Local Distribution Companies
MEMPR	Ministry of Energy, Mines and Petroleum Resources
MOP	Maximum Operating Pressure
O & M	Operations and Maintenance
ORCBC	Outdoor Recreation Council of B.C.
PCEC	Pacific Coast Energy Corporation
PMC	Project Monitoring Committee
ROV	Remote Operated Vehicle
RTU	Remote Terminal Units
Singleton	Singleton Associated Engineering Ltd. of Calgary
Vigas	Vancouver Island Gas Company Ltd.
Westcoast	Westcoast Energy Inc.

CHAPTER 1 INTRODUCTION

The provision of natural gas service to Vancouver Island has been a longstanding commitment of the Provincial and Federal Governments. Several proposals have been made over the years to extend service across the Strait of Georgia to Vancouver Island. In 1972, the Public Utilities Commission of British Columbia reviewed the matter in a public hearing. In 1979, the B.C. Energy Commission provided a report on the technical and economic considerations related to gas supply to the Island, and the Provincial Government thereafter called for Applications to provide service to the Island.

The interest in extending natural gas service to the Island was greatly heightened when the Federal Government initiated the National Energy Program in 1980. That program set a priority on extensions of natural gas service to eastern Canada and to Vancouver Island. The Federal subsidies to extend service eastward into Quebec were completed, but the Federal commitment to support service to Vancouver Island is yet to be realized.

In the spring of 1982, the Government of British Columbia called for competitive applications to deliver natural gas service to Vancouver Island. Mr. Robin J. Abercrombie prepared a report for the Ministry of Energy, Mines and Petroleum Resources ("MEMPR") entitled, "Natural Gas Supply to Vancouver Island - Technical Report".

Competitive Applications to construct transmission pipelines to supply natural gas both to, and on, Vancouver Island were made by five companies in May, 1983. The British Columbia Utilities Commission ("the Commission") reviewed the transmission aspects of delivering natural gas service to Vancouver Island and provided a report to the Lieutenant Governor in Council in June, 1984. The Commission recommended the award of an Energy Project Certificate to the British Columbia Hydro and Power Authority ("B.C. Hydro") for the construction of a natural gas pipeline to Vancouver Island from Delta to Cedar, B.C. That project was never undertaken because the required Federal and Provincial subsidies did not come to fruition.

By Order in Council No. 1741, dated September 2, 1987, the Provincial Cabinet formally rejected the Applications that remained outstanding from the 1983/84 hearings. On October 5, 1987, the Ministry of Energy, Mines and Petroleum Resources requested interested proponents capable of building a transmission pipeline to supply natural gas to Vancouver Island to submit proposals. Five companies made Application. The proposal put forward by Pacific Coast Energy Corporation ("PCEC") was chosen by the Government as the best proposal to undergo further scrutiny through a public hearing process. PCEC is a British Columbia corporate entity sponsored equally by the Alberta Energy Company Ltd. of Edmonton, Alberta and Westcoast Energy Inc. of Vancouver, B.C.

The 273.1 mm O.D. pipe would commence at Coquitlam and run northward around Coquitlam Lake and up Indian River to Squamish. The line would continue via Woodfibre, Port Mellon, Gibsons and Sechelt to a shore approach north of Secret Cove where a crossing of the Malaspina Strait to the southern end of Texada Island would occur. At the north end of Texada Island the pipeline would make underwater dual crossings to Powell River on the mainland and to Little River on Vancouver Island. The main transmission line would continue via Courtenay/Comox southward to Nanaimo and Duncan, terminating at Victoria. Laterals to the industrial complexes on the Island would be extended including lines which would service loads at the communities of Port Alberni and Campbell River. The proposed routing of the pipeline is shown schematically in Figure 1.1-1 (p. 8).

The pipeline is expected to provide natural gas to a market area with a current population of 400,000, and would reach 65,000 households, 12,000 commercial and industrial customers, and seven pulp mills.

On September 22, 1988 the Provincial and Federal Governments reached an agreement to assist the PCEC project financially. The Statement of Principles agreed to by the Governments contemplates $150 million support from each Government. The Federal Government would provide a $100 million capital grant and a $50 million capital loan, whereas the Provincial Government would provide a $25 million capital loan plus a rate stabilization facility of $70 million, as well as conversion grants of $55 million to converting customers. PCEC would be expected to provide $75 million from debt and equity contribution, to the total estimated capital cost of $250 million. These commitments were to be consummated in a Binding Agreement within one year.

PCEC submitted an Application for an Energy Project Certificate to construct the transmission facilities in November, 1988 under Part 2 of the Utilities Commission Act. On December 20, 1988 the Minister of Energy, Mines and Petroleum Resources and the Minister of Environment issued Terms of Reference to the Commission to review the PCEC Application. Those Terms of Reference requested the Commission to provide its Report and Recommendations to the Government by March 22, 1989, or as soon thereafter as possible, so that the award of an Energy Project Certificate could be accomplished in time to allow PCEC to undertake construction work in 1989 and complete its delivery of natural gas to the distribution markets by September 1, 1990. The Commission responded by issuing Order No. G-111-88 on December 20, 1988.

The Commission panel for the hearing was comprised of:

J.G. McIntyre, Commission Chairman;
F.C. Leighton, Commissioner; and
N. Martin, Commissioner.

A pre-hearing conference was held on January 18, 1989 which discussed various matters to expedite the hearing, including phasing. The parties generally agreed to the following phases for the hearing:

Phase I	Facilities and Capital Costs
Phase II	Environmental and Socio-economic Considerations
Phase III	Markets, Gas Supply and Financial Matters.

The phasing recognized that many material items with respect to markets, gas supply and financial matters were not complete for the start of the hearing on January 24, 1989 in the Commission hearing room in Vancouver, B.C. The phasing accommodated those information deficiencies by allowing the commencement of the hearing on matters that were known and allowing the Applicant to augment its Application as the hearing proceeded. Nonetheless, the Commission heard a motion on the first day of the hearing, that the hearing should be adjourned until PCEC completed its Application with respect to information on markets, gas supply and financing. The Panel responded in its ruling that the Commission must be flexible in order to recognize the needs of all parties and intervenors and to undertake a level of expediency identified in paragraph 8 of the Terms of Reference. The Commission further stated that ". . . the Commission will monitor the development and availability of deficient information and will maintain a vigilance under its mandate under paragraph 8 of the Terms of Reference . . ." (T 110).

The PCEC Application intended that its natural gas supply be received at Coquitlam from BC Gas Inc. ("B.C. Gas"). PCEC provided an alternate Application whereby the Applicant would initiate the project at the Westcoast Energy Inc. mainline station of Kilgard. PCEC later asked that the alternate Application not be considered and proceeded to negotiate a Wheeling Contract with BC Gas. PCEC noted in final argument that it continues to believe that the Kilgard alternative remains viable. This alternative Application was not considered in the hearing.

The hearing continued for seven hearing days until the completion of cross-examination of PCEC's panels on facilities, capital costs, environmental and socio-economic matters. The most active intervenors in these phases included Environment Canada, the Federal Department of Fisheries and Oceans ("DFO"), the Federal Department of Energy, Mines and Resources ("EMR"), The Council of Forest Industries ("COFI"), BC Gas Inc., Vancouver Island Gas Company Ltd. ("Vigas"), and the Greater Vancouver Water District ("GVWD"). Some intervenors were not fully prepared to complete their examination of the PCEC panels or to lead intervenor evidence until later in February. The hearing was therefore adjourned from February 2, 1989 until February 15, 1989 when Regional hearings were undertaken. On February 15, 1989 the Commission sat in Powell River and heard from various members of the Municipal and Regional Governments as well as the Powell River Chamber of Commerce. On February 16 and 17, the hearing reconvened in Nanaimo and the Commission heard Regional views from interested parties located on Vancouver Island including a representation from the Greater Victoria Water District ("GVicWD"). On February 20, 1989, the hearing resumed in Vancouver and all evidence with respect to Phases I and II was completed on February 24, 1989.

As the hearing progressed certain additional information became available. On January 27, 1989 the Minister of Energy, Mines and Petroleum Resources announced the sale of B.C. Hydro's Victoria propane pipe grid to Vigas, a subsidiary of Inter-City Gas. The sale included the rights to distribute natural gas in the Greater Victoria area. Later, on February 20, 1989, the Minister announced the award of rights to Vigas to distribute natural gas to other areas of Vancouver Island, Powell River and the Sunshine Coast. Existing petroleum gas utilities at Squamish, Nanaimo and Victoria retain their certificated rights to distribute natural gas in those communities.

On February 21, 1989 the Commission heard motions from intervenors that the level of information available with respect to the third phase of the hearing was so lacking that it would be fruitless to initiate that final phase of the hearing. The Commission responded that it would communicate with the Ministers of Energy and Environment and seek guidance with respect to continuation of the hearing. On Friday, February 24, 1989 the Ministers issued Supplemental Terms of Reference which requested the Commission to report and provide Recommendations on the first two phases of the hearing by March 14, 1989. Based on the Commission's understanding of these Terms of Reference it set final argument for the first two phases of the hearing to occur on March 1, 1989 (Commission Order No. G-15-89). Argument was completed on March 2, 1989. The Panel sat for 16 days to hear evidence and argument on the first two phases of the hearing.

On March 2, 1989 the Commission issued Order No. G-17-89 requiring PCEC to file specific information to fill the gaps in the Applicant's Phase III evidence. That material was provided to the Commission on March 6, 1989 and the hearing of Phase III evidence commenced on March 9, 1989. That last phase of the hearing remains ongoing at the time of issuance of this report, and the Commission is optimistic it will be able to provide Recommendations to the Lieutenant Governor in Council by March 22, 1989, or as soon thereafter as possible.

CHAPTER 2 LAND PIPELINE FACILITIES AND CAPITAL COSTS

2.1 Introduction

2.1.1 PCEC's Application

PCEC proposes to construct a main transmission system, approximately 455 km in length from Coquitlam, near Vancouver, to Victoria. The main transmission system will traverse 492.5 km of land and 44 km of water enroute to Victoria. Gas is to be sourced directly from the BC Gas system near Coquitlam. Initially one compressor station (Station V-1), is required near Coquitlam with a second (Station V-2), installed near Sechelt on the Sunshine Coast for in-service year 10 (1999).

As proposed, the total pipeline transmission system will include lateral pipelines (pipelines installed to serve markets some distance from the main transmission system), totalling slightly over 98 km in length (89 km on land and a 9 km water crossing). The general route of the proposed transmission system is shown on Figure 2.1-1.

PCEC has retained Westcoast Energy Inc. ("Westcoast") as its agent for the design and construction, and proposes to retain Westcoast for the operation of the proposed pipeline transmission system. PCEC is confident that it will construct the proposed pipeline transmission system in compliance with the highest standards of pipeline practice from all relevant perspectives.

In routing its main transmission system from Coquitlam to Victoria, PCEC proposes to provide natural gas enroute to communities and industrial loads located at Squamish, Woodfibre, Port Mellon, Gibsons, Sechelt, Texada Island and Powell River (via a lateral pipeline). On-island gas service is proposed to 15 island communities and industrial loads at various locations (from meter

PACIFIC COAST ENERGY CORPORATION
VANCOUVER ISLAND PIPELINE PROPOSAL

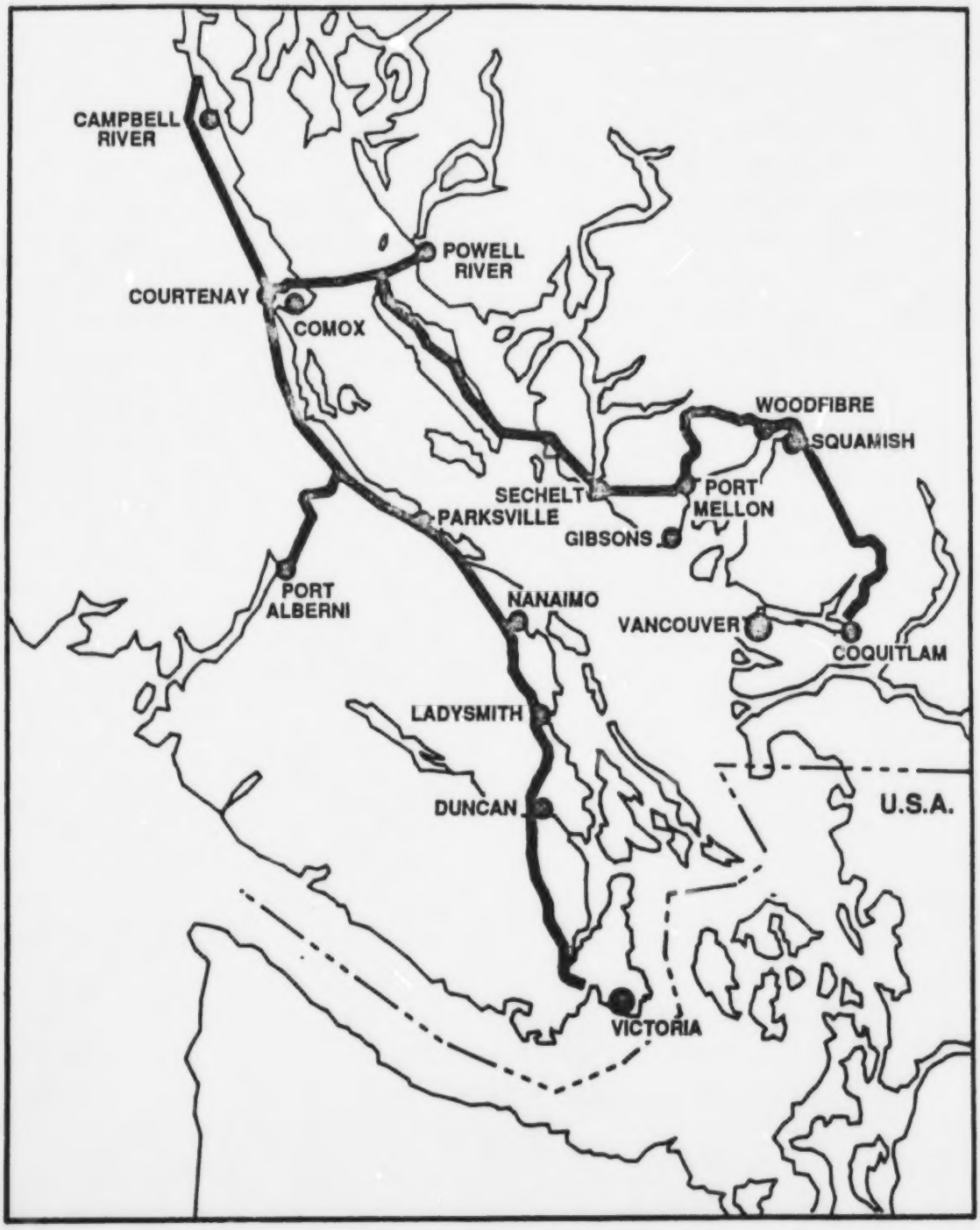

FIGURE 2.1-1

stations on the main transmission line and via lateral pipelines to meter stations at the end of the laterals) including Campbell River, Comox, Nanaimo, Duncan, Port Alberni and Victoria.

The total pipeline system, initially comprised of about 536 km of main transmission and lateral pipelines (492.5 km of pipeline on land and 44 km of dual pipeline water crossings), one compressor station and 23 gas metering stations, is to be designed, constructed, tested, commissioned and placed in service by September 1, 1990, based on project approval not later than April 1, 1989, at a total estimated capital cost of $248,453,000 in as spent 1989/1990 dollars.

TABLE 2.1 - 1

Initial Capital Costs
($000)

o	To-Island Transmission (including Powell River)	$157,260
o	On-Island Transmission	78,656
o	Meter Stations	4,623
o	Operating and Maintenance Facilities	6,442
o	Communications and Telemetry	1,472
	TOTAL	$248,453

On a similar basis, the initial estimated capital costs may be restated as follows*:

	Land Facilities		Dual Marine	Total
	Pipeline	Other	Crossings	System
Direct Costs	$145,961	$22,687	$42,396	$211,044
Indirect Costs	25,210	3,902	8,297	37,409
TOTAL CAPITAL COSTS:	$171,171	$26,589	$50,693	$248,453

* See Exhibit 3, Tab 12

Direct costs include the estimated costs for all land and land rights, materials, installation, start-up and test heads (test heads are removed prior to start-up) and inspection. Indirect costs include engineering and overheads costs, estimated costs for omissions and contingency, and an allowance for funds used during construction ("AFUDC"). AFUDC covers the interest on the capital used for the design and construction of the pipeline system up to the point that the system is placed in service; it is therefore tied directly to the project schedule and the expenditure profile. Other costs, tabulated under Land Facilities - Other, include estimated costs for compressor Station V-1, 23 meter stations, operation and maintenance facilities and communications/telemetry requirements.

Design of the pipeline system has been based upon a market study carried out in 1988 and a year-20 design maximum of 3,805 10^3m^3/D (135 MMScf/d). Facilities initially constructed for September 1, 1990 operation will provide an initial maximum capability of 1,836 10^3m^3/D (65 MMScf/d). Additional compression facilities are to be installed in the 4th, 7th, 10th and 15th operating years, at an estimated cost in as-spent dollars of $41,781,000 to bring the total cost of facilities over a 20-year period to $290,234,000 in as-spent dollars.

The optimal pipeline capacity for the main transmission system proposed is estimated at a maximum capacity of approximately 4,250 10^3m^3/D (150 MMScf/d) with five compressor stations. PCEC filed Exhibit 75 in response to Panel direction. That filing incorporates revised market data under Tab 9. The increased peak day throughput will necessitate some advancement of compression additions but the eventual load in year-20 remains less than 150 MMScf/d.

2.1.2 PCEC's Alternative Application

In early December 1988, PCEC filed an alternative Application to cover the sourcing of gas from the Westcoast mainline system near Huntington at a location about 4 km south east of Kilgard. The alternative Application (the Kilgard option), would require the construction of an additional 63 km of transmission pipeline from Westcoast's system to join the route alignment of the original Application (the Coquitlam option) at a point about 7 km north of the BC Gas source location near Coquitlam. It would also involve the relocation of the initial compressor station to a gravel pit on the banks of the Fraser River north of Sumas Mountain and eventually, two intermediate compressor stations, at Squamish and at Comox, rather than one station at Sechelt, as in the Coquitlam option.

Subsequent to the filing of the alternative Application, PCEC advised the Commission that negotiations were ongoing with BC Gas to secure sourcing from their system near Coquitlam, and that the parties expected to conclude a formal agreement. On this basis the Commission accepted the PCEC motion that the alternative Application be set in abeyance. No review of the facilities or environmental implications has occurred and the Commission therefore cannot recommend any action on the alternative Application.

2.1.3 Inland Natural Gas Co. Ltd. and BC Gas Inc. Submission

On January 19, 1989, Inland Natural Gas Co. Ltd. and BC Gas filed an intervention with the Commission. BC Gas, having undertaken engineering, environmental and economic studies, submitted that the use of BC Gas facilities in conjunction with a redesigned Coquitlam option (the modified Coquitlam option) is superior to PCEC's Kilgard option.

The modified Coquitlam option as submitted by BC Gas differed from PCEC's Coquitlam option in a number of respects. It considered relocating compressor Station V-1 to a point 5.8 km north of the BC Gas Westwood Gate Station, an increased inlet pressure to Station V-1, a reduced discharge pressure from Station V-1, two downstream compressor stations at Squamish and Comox (as PCEC had considered in their Kilgard option) and most significantly, a lower rate for transportation of gas to PCEC by BC Gas (wheeling charges of BC Gas) than was reflected in Volume 6 of PCEC's Application (Exhibit 8, Tab 2, pp. 3 and 4). An Agreement between PCEC and BC Gas was not concluded during the duration of the hearing of Phases I and II evidence.

2.1.4 Council of Forest Industries' Submission

COFI introduced written direct evidence (Exhibit 58) in support of its intervention. COFI, in late June 1988, had retained Singleton Associated Engineering Ltd. of Calgary ("Singleton") to review the overland pipeline capital cost that PCEC had prepared in support of its proposal to the British Columbia MEMPR of November, 1987. Their Report "Vancouver Island Pipeline Review for the Council of Forest Industries - July 11, 1988" documented their review.

Singleton did not prepare an independent cost estimate but did review the land pipeline costs. They argued that costs could rise $25 to $45 million over PCEC estimates.

2.1.5 Greater Vancouver Water District's Submission

Two consultant reports (Exhibits 64 and 66) were introduced by the GVWD in support of its intervention before the Commission. Coincidental with the introduction of the reports GVWD advanced evidence in two panels. The first was the City of Vancouver Medical Health Officer. The second was comprised of GVWD's Chief Engineer and the authors of the respective reports.

Thurber Consultants Ltd.'s Report "Proposed Natural Gas Pipeline in Coquitlam Lake Watershed - Geotechnical Assessment - February 16, 1989" (Exhibit 66) presented a geotechnical overview of concerns arising from PCEC's proposal to locate the Vancouver Island Natural Gas Pipeline in the Coquitlam Lake watershed. The geotechnical assessment related directly to the environmental concerns associated with maintaining water quality during and after the construction of the PCEC pipeline. It included:

- Consideration of anticipated construction conditions along the proposed pipeline routes;
- Comments on excavation and disposal of trench materials, slope stability, stream crossings and sedimentation; and
- Recommendations that PCEC be requested to provide detailed information on planning for construction and maintenance on the pipeline and rapid response in case of an accident or natural storm event.

Economic and Engineering Services Inc.'s report "Greater Vancouver Regional District - Drinking Water Quality Impact Assessment Report - Proposed Natural gas Pipeline through Coquitlam Watershed - February 16, 1989" (Exhibit 64) summarized its findings on the potential impact of a 273.1 mm diameter natural gas pipeline as proposed by PCEC in the Coquitlam watershed. The Report:

- Documented the potential impacts on the watershed and on drinking water quality;
- Raised water quality concerns of turbidity, human waste and petroleum products;
- Emphasized that the GVWD gains no water quality improvement but assumes water quality risks; and
- Recommended the development of a water quality protection plan if the proposed pipeline project is approved.

PCEC, as a result of its January 26, 1989 meeting with GVWD (T 465), had undertaken the preparation of detailed documentation for the GVWD of its design, methods of construction, operation and maintenance, and plans to minimize and mitigate the adverse impacts and risks associated with routing the proposed pipeline through the watershed. That documentation was to be presented to the GVWD very early in March. PCEC was advised that the GVWD would take a month to consider that, with final consideration being given at a monthly meeting of the Greater Vancouver Regional District toward the end of March.

2.1.6 Greater Victoria Water District's Submission

The GVicWD introduced as evidence a brief outlining its concerns with respect to the location of the proposed pipeline through the closed and protected Greater Victoria watershed area. The route selected for the pipeline crosses the extreme southeast corner of the watershed, through the Niagara watershed, for a distance of about 7 km. GVicWD, at this time does not take any water from the Niagara watershed.

The brief submitted by GVicWD objected to the proposed pipeline route being located within its lands on the basis that it would aggravate the GVicWD's ability to fulfill its mandate. GVicWD advised that there was a sense that if the pipeline is constructed, it will go through the watershed lands despite the GVicWD's opposition to it, and for that reason, GVicWD wanted to document its concerns.

PCEC is continuing its efforts to alleviate GVicWD's concerns. The major concerns revolve around increased access to GVicWD lands and the GVicWD's general reluctance to permit utility corridors through its lands.

2.2 PCEC Proposal

2.2.1 To Vancouver Island

Land pipeline facilities proposed for the transmission of natural gas to Vancouver Island include:

- Three land pipeline segments:
  - The Coquitlam segment, a 1.8 km, 610 mm O.D., 3,540 kPa (500 psia) Maximum Operating Pressure ("MOP") pipeline to facilitate the transmission of low pressure gas from the source of supply at the BC Gas Westwood Gate Station to the suction side of PCEC's initiating compressor station.
  - The Coquitlam-Sechelt segment, approximately 157.55 km of 273.1 mm O.D., 14,890 kPa (2,160 psia) MOP pipeline to carry the gas from the Lower Mainland to the landfall of the dual marine crossing of the lower Malaspina Strait at a location north of Secret Cove on the Sunshine Coast.
  - The Texada Island segment, approximately 47.93 km of 273.1 mm O.D., 14,890 kPa MOP pipeline to transport the gas from the dual marine crossing landfall near the southeastern end of Texada Island to the northern end of Texada Island.
- Low pressure lateral pipeline facilities of 114.3 mm O.D. to deliver gas from the downstream side of meter stations on the high pressure transmission system to the property line of pulp mills at:
  - Woodfibre (a 0.5 km lateral) from the Woodfibre meter station located on the Squamish-Sechelt segment just west of Squamish Harbour in Howe Sound.
  - Port Mellon (a 0.7 km lateral) from the Port Mellon meter station located on the Squamish-Sechelt segment on the west shore of Thornbrough Channel of Howe Sound.
  - Powell River (a 3.0 km lateral) from the Powell River meter station at the end of the northern Malaspina Strait dual marine crossing lateral on the Mainland Coast approximately midway between Powell River and Westview.

- Compressor Station V-1 located near Coquitlam to increase the pressure of the gas received from BC Gas to the MOP of the 273.1 mm pipeline. Initial compression will most likely be provided by two 4,100 kW (3,000 HP nominal) industrial gas turbine driven compressor packages. Three additional 4,100 kW units will be added in ensuing years as the pipeline system throughput increases with market demand.

- A gas measurement facility (meter station) will be installed as a part of compressor Station V-1 to measure the total gas flow into the pipeline system.

- A future compressor Station V-2, one 4,100 kW unit, proposed to be installed for in-service year-10 (1999) at a point approximately 14 km west-northwest of Sechelt, to raise the pressure of the flowing gas back to near the MOP of the 273.1 mm pipeline system to ensure adequate gas flow and pressure to the downstream meter stations.

- Seven meter stations on the B.C. mainland and Texada Island to measure gas delivered to residential, commercial and industrial consumers:

  - Six meter stations are to be located on the main transmission line to serve Squamish, Woodfibre, Port Mellon, Gibsons, Sechelt and Texada Island.

  - One meter station is to be located at Powell River at the end of the northern Malaspina Strait from the northern end of Texada Island.

- Communications and telemetry equipment required for the operation of the pipeline transmission system from a "master" station at the Westcoast Gas Control Centre in Vancouver.

- Operating and maintenance facilities consisting of a pipeline shop and the required equipment and vehicles necessary for the field operations, maintenance and routine repair of pipeline, compression, meter station, communications and telemetry facilities associated with land pipeline facilities to Vancouver Island.

2.2.2 On Vancouver Island

Land pipeline facilities proposed for the transmission of natural gas on Vancouver Island include:

- The pipeline between Comox and Victoria, approximately 212.4 km of 273.1 mm O.D., 14,890 kPa MOP main transmission system pipeline to transport the gas from the dual marine crossing landfall at Little River near Comox to Langford, near Langford Lake, west of Victoria proper.

- Lateral pipeline facilities of 114.3 mm, 14,890 kPa MOP to deliver gas from the main Comox to Victoria transmission system pipeline to:

  - Campbell River (the 48.8 km Campbell River Lateral) from a location in the vicinity of Courtenay.

  - Port Alberni (the 21.0 km Port Alberni Lateral) from a location in the vicinity of Dunsmuir approximately 15 km northwest of Qualicum Beach.

  - Crofton (a 4.8 km lateral) from a point about 1 km west of Westholme and 10 km north of Duncan.

- Low pressure lateral pipeline facilities of 114.3 mm O.D. to deliver gas from the downstream side of meter stations on the high pressure transmission system to the property line of pulp mills at:

  - Port Alberni (a 1.8 km lateral) from the Port Alberni meter station at the end of the Port Alberni Lateral near the northeastern outskirts of Port Alberni.

  - Harmac (an 8.5 km lateral) from the Harmac meter station located on the Comox-Victoria segment at a location about 2 km southwest of South Wellington.

- Fifteen meter stations on Vancouver Island to measure gas delivered to consumers:

  - Eleven meter stations are to be located on the main transmission line to serve Comox, Courtenay, Cumberland, Qualicum, Parksville, Nanaimo North, Nanaimo South, Harmac, Ladysmith, Duncan and Victoria .

- Two meter stations are to be located on the Campbell River Lateral, the South Meter Station at a location about 5.7 km from the end of the lateral some 2 km south of the proposed pipeline crossing of Campbell River and about 3 km west of the geographic centre of Campbell River proper, and the North Meter Station at the end of the lateral near the south eastern shore of Duncan Bay.

- One meter station is proposed to be located at the end of the Port Alberni Lateral near the north eastern outskirts of Port Alberni.

- One meter station is proposed to be located at the end of the Crofton Lateral about 1.5 km north of Crofton.

o Vancouver Island based communications and telemetry equipment necessary for the operation of the pipeline transmission system from the "master" at the gas control centre in Vancouver.

o Operation and Maintenance facilities on Vancouver Island similar to those proposed for the B.C. mainland.

2.2.3 Total Land Pipeline Facilities

Total land pipeline facilities, as described in the preceding subsections, have been located by PCEC to combine the best of earlier proposals.

Its main transmission pipeline system commences from the Lower Mainland and avoids the more expensive costs associated with northern overland pipeline construction. Enroute to the northern Strait of Georgia crossing are significant mainland loads which will be served without major laterals.

As a result of ongoing negotiations between PCEC and COFI, subsequent to the filing of the original Application, PCEC amended and revised its Application to include the high pressure pipeline lateral to the pulp mill at Crofton and the low pressure pipeline laterals to the pulp mills located at Woodfibre, Port Mellon, Powell River, Port Alberni and Harmac. The length of transmission main and lateral pipelines and low pressure lateral pipelines are essentially firm, subject only to minor revision resulting from finalization of route alignment during the detailed design phase of the project.

Subsequent to the filing of the Application, an announcement by the Provincial Government to subdivide land in the area of the proposed siting of compressor Station V-1 presented an unexpected problem to PCEC. Additional siting studies were immediately initiated. Investigation is continuing. A site slightly to the north and west of the original site has tentatively been selected, which with the incorporation of further safeguards regarding sound levels, would be satisfactory.

During the course of investigating alternative sites for Station V-1, PCEC looked at a number of locations in the Coquitlam and Coquitlam watershed areas, but unfortunately many of the locations, including one suggested by BC Gas, proved to be geotechnically unstable. The location finally selected is judged by PCEC to be the most suitable location in the area, all factors considered. The only impact on main transmission pipeline length is to marginally increase the Coquitlam 610 mm O.D. segment and to similarly decrease the Coquitlam-Sechelt 273.1 mm segment.

In filing its amendments (Exhibit 10) to the Application in late December, PCEC revised the location of a number of meter stations based on discussions it had undertaken with one of the potential local distributors subsequent to its original filing. PCEC further advised that upon an announcement of the successful candidates for the rights to distribute gas in the various communities on the Island and on the Sunshine Coast, it would enter into discussion with those distributors and, as soon as agreement in principle was reached, results would be filed with the Commission (T 47).

Vigas was awarded the sole right to distribute gas on Vancouver Island and the Sunshine Coast. PCEC-ICG Utilities (British Columbia) Ltd. ("ICG") discussions are continuing and agreements made in these instances, along with final agreements with the mills could result in further revisions to meter station locations, and possibly a change in the total number of meter stations for the initial phase of construction.

PCEC, in its response to COFI's Information Request 2 (Exhibit 51) provided COFI with the estimated costs for a typical pulp mill metering and regulatory station. PCEC indicated that it is not its present intention to build the meter and regulator stations for each mill and advised that costs were not included in its present capital cost estimate for that eventuality (T 1639).

The communications and telemetry facilities to be installed on both Vancouver Island and the mainland will include Remote Terminal Units ("RTU's") connected to their gas control centre in Vancouver. RTU's, in addition to being located at all compressor stations, will be installed in the larger meter stations.

Operations and Maintenance ("O & M") facility bases will most probably be located in the Sechelt area on the Sunshine Coast and in the Nanaimo area on Vancouver Island. The locations will be finalized to position operations and maintenance personnel in localities that will be most convenient to their activities up and down the respective length of the transmission pipeline system facilities on the B.C. mainland/Texada Island and on Vancouver Island.

2.3 Routing

2.3.1 Route Selection

In submitting its initial proposal, PCEC proposed an overall route which they believed would combine the best of earlier proposals, avoid costly northern overland pipeline construction, incorporate the least costly crossing of the Strait of Georgia as evidenced in the 1983/84 hearings and maximize the market area to be served.

Some years ago, Westcoast had looked at mainline routing to Powell River from the Lower Mainland which would involve crossings of various stretches of Jervis Inlet. Crossing the Jervis Inlet proved insurmountable because of the extreme depth and the high tides (T 1707). A viable routing from Sechelt to Powell River could not be located. An inland route from Squamish northwesterly through valleys to a crossing of Queens Reach at the top end of Jervis Inlet was also considered. Routing from the crossing of Queens Reach into Powell River would traverse very difficult terrain for a considerable length. In addition, a lateral would be required to serve Woodfibre, Port Mellon and Sechelt. With the current load forecast Texada Island would not be served.

PCEC, having incorporated the least costly crossing of the Strait of Georgia from Powell River to Comox, selected a southern Malaspina Strait crossing from the area north of Secret Cove on the Sunshine Coast to Texada Island north of Anderson Bay. The actual location for the southern marine crossing, to be selected during detailed design, would not materially affect the land pipeline routing.

With the fixed control points of marine crossing landfalls and major market areas defined, PCEC routed its land pipeline having regard to the:

- Expected environmental impact;
- Location of existing BC Gas facilities;
- Existing power line rights-of-way;
- Total pipeline mileage required;
- Location of high-density populated areas;
- Ease of access for construction and operation;
- Ease of pipeline construction; and
- Proximity to various cities, communities and industries that could be served.

PCEC maintained throughout its evidence and closing argument that the selected mainland and on-island portions of the route are expected to have the lowest environmental impact and, additionally, will minimize the pipeline investment while ensuring a maximum of pipeline access for both operation and continuity of public service. Further, it does not believe that the land pipeline routing encounters any environmentally sensitive areas other than those associated with certain stream and river crossings, or that it presents any unusual degree of construction difficulty.

The proposed land pipeline routing, as shown on route maps (Exhibit 10) and pipeline mosaics (Exhibits 6 and 10) depicts the preliminary routing selected for Application purposes. Route alternatives have been considered. Ongoing route refinement is in progress. New pipeline mosaics have been produced from aerial photography flown in late 1988, route refinements incorporated, and the proposed alignment as of mid-February 1989 issued to contractors for bid purposes. Routings for the low pressure laterals, the subject of PCEC's revised Application of February 10, 1989, are to be shown on mosaics currently under preparation and will be issued as an addendum to contractors for incorporation in the bidding process.

Route refinement, based on the finalization of river and stream crossing locations which commenced in early February 1989, together with field line location and land acquisition will not commence until immediately following the award of an Energy Project Certificate.

The routing of the land pipeline as submitted to contractors for bid is marginally different than that reflected in the Application, as amended and revised. The alignment has incorporated alternative routing refinements of a minor nature and one alternative route segment along the Coquitlam to Woodfibre portion of the route.

2.3.2 Route Alternatives

In response to Commission information requests PCEC provided brief comparisons in terms of environmental acceptability, construction difficulty and costs associated with route alternatives in seven areas. Two of the alternatives were under active study, one was investigated as a result of the requests and four on Vancouver Island had been generally considered in 1982/83, in 1987 and again as a result of the request.

- Coquitlam Lake (38 km) vs. Indian Arm (28 km) Routing
  - Indian Arm, while environmentally more acceptable and shorter, would be much more difficult and more costly to construct due to steep and rocky terrain, the presence of numerous small private holdings along the inlet, and the location of the existing 500 kV transmission powerline.
  - Estimated cost - almost $20 million more for Indian Arm ($33.5 vs. $14.7 million).
  - The Coquitlam Lake routing is preferred. Negotiations are ongoing. Detailed information has been provided to Coquitlam watershed authorities and PCEC expect final consideration towards the end of March.
- Rainy River (20 km) vs. McNabb Creek (18 km) Routing
  - Estimated cost - $2.6 million less for McNabb Creek ($6.1 vs. $8.7 million).
  - The McNabb Creek routing is preferred and has been incorporated in the bid documents forwarded to contractors.
- Sechelt Village vs. Porpoise Bay Route
  - Land routing through Sechelt Village and the Sechelt Indian Reserve will parallel an existing powerline right-of-way and pass close to commercial and residential developments. The Porpoise Bay crossing, by directional drilling or conventional means, had been considered only as an alternative if negotiations with land owners are not productive.

o Vancouver Island Route Alternatives

- PCEC, in response to Commission information requests to consider four alternative route segments similar to B.C. Hydro's preferred routing of 1982/83, strongly endorsed its own corporate routing philosophies. It is of the opinion that it is best to route a high pressure transmission pipeline along an existing corridor, at some distance from settlements, for reasons of safety and to avoid conflicts with existing and future land users.

- Estimated costs were not quantified for the Vancouver Island route alternatives as the differences were considered to be insignificant. PCEC expressed a strong preference for its overall island routing as selected, agreed that the alternatives were viable and that if there were compelling reasons to adopt one of the alternatives, it would do so.

- West and east of Shawnigan Lake, km 169 to km 200, PCEC's west of Shawnigan Lake route along the abandoned railroad right-of-way is preferred for terrain, river crossing, heritage and agricultural reasons.

- West vs. Coastal Route near Qualicum, km 47 to km 61, PCEC's marginally shorter western route, is along the powerline right-of-way and avoids small coastal communities.

- Campbell River Lateral, km 0 to km 49, PCEC's western route, along the powerline right-of-way is preferred despite the impact on sensitive wet lands since it reduces disturbance to settlements, wildlife, forestry and fisheries.

- Port Alberni Lateral, km 0 to km 21, PCEC's route along existing and abandoned powerline rights-of-way north of Horne Lake is preferred to B.C. Hydro's route to the south of Horne Lake. It was noted that the northern route was also preferred by ICG and Inland Natural Gas Co. Ltd. in their earlier submissions.

2.3.3 Route Refinements

Areas requiring further route refinement prior to the commencement of detailed line location include:

- Those associated with a few stream and river crossing locations that may be relocated upstream or downstream as a result of the current investigations.
- Approaches to the landfalls at the beachheads:
  - the lower Malaspina Strait crossing, both on the mainland north of Secret Cove and on Texada Island;
  - at the north end of Texada Island, one or two beachheads are under consideration for the main transmission pipeline to Little River and for the lateral pipeline to Powell River; and
- Areas of the route where terrain/hydrology is of a concern, and where further study and some field investigations are to be undertaken include:
  - sections along Coquitlam Lake;
  - segments between Squamish and Woodfibre and from Woodfibre to Henriette Lake;
  - on Vancouver Island along the Port Alberni Lateral; and
  - river crossings which have been identified as possible candidates for aerial spans or directional drilling.

Final route refinement during the line location/land acquisition stage prior to construction may result in minor alignment modifications in specific locations to accommodate land owner requests.

In arriving at the route alignment for bid purposes, PCEC believes that, in all areas other than those mentioned above, it has defined very closely the land pipeline alignment along which the pipeline will be constructed. The alignment selected is largely contiguous to existing power lines and has minimized the need for new access. Something in the order of only 50 km (about 10% of the total land pipeline system) will require new access and the wider right-of-way grade associated with it. Areas where present access does not exist include:

- 10 km in the upper Coquitlam River Valley;
- 8 km between Squamish and Woodfibre;
- 7 km between Henriette Lake and the upper Sechelt River Valley;
- 4 km between Box Canyon and the lower Rainy River;
- 4 km north of Secret Cove;
- short segments on Texada Island;
- 2 km west of Campbell River;
- 3 km on the Port Alberni Lateral;
- a few access points to stream crossings along the powerline right-of-way on the Comox to Victoria mainline; and
- a few areas where a temporary shoo-fly is necessary for the contractor to access around difficult terrain (shoo-flys are necessary where the pipeline right-of-way grade is too steep for travel).

The alignment has been, or will be, finalized to reduce some of the seismic induced risks in that:

- it has been routed along lower valley terraces and level ground where possible to avoid steep terrain and side hill;
- it avoids, where possible, areas where soils are unstable and horizontal soil movement is evident;
- generally, the route is located in areas where erosion products and mass wasting will add to the depth of cover over the pipeline.

2.3.4 Conclusions

The Commission concludes that the total land pipeline facilities proposed for the transmission of natural gas to and on Vancouver Island are adequate as to length, general location to service the projected markets and the number of compressor stations, meter stations and O & M bases. Confirmation of markets and peak delivery requirements will occur in Phase III of the hearing.

The Commission is convinced that the detailed land pipeline routing, and the ongoing route refinement, will produce an optimum route. All factors considered, this route will ensure the lowest possible construction difficulty. The Commission further accepts that PCEC will expeditiously and satisfactorily resolve specific alignments which conflict with other existing and proposed land uses.

The Commission concludes that the route selected by PCEC, as modified during the process of route refinement, is acceptable. It has found no compelling reason to recommend rerouting of any portion of the land pipeline facilities.

The routing of the pipeline through the Coquitlam watershed or along Indian Arm was debated thoroughly at the hearing. From a reliability and cost standpoint it is clear that the routing through the Coquitlam watershed is far superior to Indian Arm. In fact, the Indian Arm route would be so difficult that the Commission cannot endorse it unless there is no other option. The environmental concerns of the GVWD are addressed fully in Chapter 4 of this report.

2.4 Facility Design

2.4.1 Pipeline Size Selection

Having selected the route of the proposed pipeline, PCEC conducted studies to determine the size of the pipeline required. Peak day requirements were estimated from statistical data pertaining to other similar loads for Local Distribution Companies ("LDC's) and Large Industrial customers in other areas of the Province. The resultant peak day volumes, exclusive of PCEC's fuel and unaccounted uses and losses, for operating years 1, 5 and 20 (as derived from Exhibit 10, Tab 6) follow:*

TABLE 2.4-1

	Peak Day Gas Sales Volume	
Year	$10^3m^3/D$	MMScf/d
1	972	34.30
5	1985	70.09
20	3272	115.52

For each of three systems considered, PCEC performed flow studies to determine the extent of compression facilities (and additional pipeline loop in one instance) and fuel requirements necessary to achieve its design maximum flow. Total capital costs and operating and maintenance costs were estimated for each system, cost of service was determined, results were compared and further considerations as to the flexibility of each system design to accommodate unanticipated load growth was assessed.

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* Subsequent to the completion of Phases I and II evidence and argument, PCEC filed revised market data increasing peak day sales in all years.

Table 2.4-2 following presents summary details of the three alternative systems considered.

PCEC selected the 273.1 mm 2160 psig system over the 323.9 mm 1440 psig system based on:

- Lowest first year capital cost.
- Lowest project total capital cost over a 20-year period.
- Lowest first year unit cost of service.
- Lowest 20-year discounted accumulated cost of service.
- System capacity over the 20-year forecast period without benefit of looping.

The 273.1 mm 1440 psig alternative system, while it provided for a marginally lower first year capital cost ($11.8 million) and a lower first year unit cost of service (12% lower) was eliminated due to:

- Less flexibility in early years to accommodate load growth---limited capacity prior to first station addition.
- Less flexibility in the long run to accommodate unexpected load growth---its optimum sales capacity prior to the commencement of looping is in the order of 109 MMcf/d.
- Higher total capital costs over 20 years---$20.3 million in 1990 $'s and $43.5 million in escalated dollars.

During the hearings it was suggested that a significant unanticipated load (50 MMcf/d) could develop in the Victoria area (T 179). The selected 273.1 mm 2160 psig system would have more flexibility to handle such an event, regardless of the timing when it might materialize. Since the sales capacity of the selected system prior to the addition of a second compressor station is 86 MMcf/d, and the first year sales volume is projected to be 34 MMcf/d, ample time would be available to PCEC to optimize its installation of pipeline and compression facilities to accommodate the higher 20-year design sales volume.

TABLE 2.4-2

Pipeline Size Selection Summary
Alternative System Studies

CASE	273.1mm-2160	273.1mm-1440	323.9mm-1440
System Definition			
- Pipe O.D. - mm	273.1	273.1	323.9
- Pipe MOP			
- kPa	14890	9930	9930
- psig	(2160)	(1440)	(1440)
- Project Period (yrs.)	20	20	20
- Looping	No	Yes	No
- No. Compressor Stations	2	5	5
- Sales Capacity (MMcf/d)	127	127	127
- Capacity (MMcf/d) Before First Station Addition	86	55	86
- Optimum System Design			
- Looping	No	No	No
- No. Compressor Stations	5	5	5
- Sales Capacity (MMcf/d)	152	109	156
Capital Costs ($000's)			
- First Year 1990 $'s	248,453	236,690	260,907
- Total - 20 yrs. 1990 $'s	274,496	294,837	279,977
- Escalated $'s	284,168	327,668	287,977
Cost of Service			
- First Year Unit Cost ($/GJ)	1.109	0.980	1.236
- 20-Year Discounted Cost of Service (1990 $000)	176,989	176,728	182,715

In the event that Phase III evidence on market projections results in a 20-year sales forecast substantially in excess of the projections utilized by PCEC, consideration should be given to possibly upsizing a portion of the pipeline system to 323.9 mm O.D. If the projected 20-year market demand were firmed-up prior to ordering pipe, and if it was in excess of 150 MMcfd, it would make economic sense to look at installing 323.9 mm O.D. pipe from Coquitlam through to Squamish, or beyond. The incremental dollars associated with laying 323.9 mm vs. 273.1 mm O.D. pipe through the Coquitlam watershed, across the Coquitlam, Indian and Squamish Rivers and up the steep rocky slope southwest of Squamish might be well spent, and prove in the long run to be an optimum solution.

The Commission concludes that the pipeline size selection by PCEC, while it does not produce the lowest possible first year capital cost and first year cost of service, is the most economic solution in the long run, based on current estimates of throughput. The Commission believes that the pipe size/pressure selected will prove to be the most flexible solution to maintaining the lowest cost of service for supply of gas to communities and industries.

2.4.2 Flow Formula and Flow Diagrams

PCEC's flow formula as utilized (in conjunction with the formulae to determine temperature profile, transmission factors and compressor horsepower) for the design of the proposed system, for the pipeline size selection studies and to prepare the flow diagrams presented in the Application for peak day and maximum capability for in-service years 1 through 20 produced consistent results, which, when benchmarked against more rigorous analysis formulae, showed close correlation.

PCEC, in response to a consideration as to spare unit availability, conducted further flow studies assuming the loss of a unit at Station V-1, both with suction pressures as assumed in the Application and with higher suction pressures, and advised that:

- On the basis of the lower suction pressure currently in the Application, the greatest loss in throughput resulting would be:
  - Year 3 13 MMcf/d
  - Year 6 12 MMcf/d
- On the basis of the delivery pressure that is likely to result from final negotiations with BC Gas, there would be no loss in throughput, and
- If the suction pressure at Station V-1 remains above 400 psia, there would also be no loss in throughput.

The Commission is convinced that, with the pipeline size selected, PCEC will be able to conduct its future expansion of the pipeline system to stay ahead of market growth in a manner that will result in the lowest cost of service to consumers. The Commission expects that PCEC will be capable of maintaining peak day throughputs with the loss of a unit at the initiating station and further, in future years it would expect PCEC to have in place a contingency plan to ensure that peak day demands of LDC customers, and the contractual demands of the large industrial consumers, can be met in the event of a unit outage at Station V-2.

The Commission further concludes that the flow formulae utilized by PCEC are adequate for pipeline design and analysis and that the flow diagrams presented in the Application are accurate.

2.4.3 Pipeline Design

The land pipeline transmission system facilities will be designed in accordance with the provisions of appropriate governing codes, such as the latest editions of the Canadian Standards Association - CAN/CSA-Z184-M86, the American Society of Mechanical engineers - ASME Standards, and accepted industry practices. The CSA-Z184 Gas Pipeline Systems Standard covers the design, fabrication, installation, inspection, testing, and safety aspects of the operation and maintenance of gas pipeline systems including gathering lines, transmission lines, compressor stations, metering and regulating stations, distribution lines, and service lines.

Pipeline design involves the design and selection of permanent materials---the pipe, valves, flanges and fittings for appurtenance, the line pipe, the pipe coatings---both internal and external, and special and/or typical designs for road, rail, river and stream, foreign pipeline, and other crossings, valve and trap assemblies (appurtenances), etc. It also includes the design of the right-of-way and of the ditch in which the pipe is to be buried, the design of the bending, welding and coating of the pipe, the design and selection of special materials (both manufactured and native materials to protect and to hold in place the pipe as it is placed in the ditch and backfilled), and finally the design of the testing program to prove the integrity of the installed pipeline system.

The design proposed by PCEC meets, and in instances exceeds, the minimum requirements of governing codes, and standard industry practice. In most cases the standards can be found in Westcoast specifications filed in response to Commission staff information requests.

Pipeline appurtenance designs completed at this stage include:

- o BC Gas tie-in assembly;
- o Compressor Station V-1 tie-in assembly;
- o All sending and receiving barrel assemblies including those for the dual marine crossings; and
- o Typical block valve and sales tap assemblies.

Designs for typical crossings have been completed. Site specific crossing designs where deemed necessary will be forwarded to contractors for bid prior to April 1, 1989. Typical and site specific crossing drawings include:

- o River and creek crossing;
- o Minor creek water runoff and ditch crossing;
- o Flumed river or creek crossing;
- o Foreign pipeline crossing;
- o Road crossing;
- o Cased railway crossing; and
- o Buried cable crossing.

PCEC, in submitting its pipeline design to bid, has provided for preferred and alternative crossing techniques for rivers and streams. Detailed design (as opposed to typical design) will be required for a number of the crossings regardless of the crossing technique finally selected. The principal crossing techniques include:

- o Open Cut;
- o Flumed;
- o Aerial; and
- o Directional Drilled.

Pipeline design for open cut and flumed crossings is identical except for implicit construction considerations.

Aerial crossings, if eventually selected for specific locations, will not be installed by the main pipeline contractor. Detailed designs for specific and/or typical spans will be developed and bid separately. Aerial crossings have tentatively been selected for the Puntledge, Qualicum, Little Qualicum, Nanaimo, Chemainus, Cowichan, Koksilah, Goldstream Rivers and Waugh and Banon Creeks. The Banon would be crossed with the Chemainus River span.

With respect to directional drilling, PCEC in its bid documents has:

- o Encouraged the contractor to consider directional drilling any river or stream crossing or other special problem areas.
- o Reserved the right to have the contractor retain a directional drilling contractor for the installation of:
  - 4 river crossings on the mainland;
  - 2 areas of difficult terrain on the mainland;
  - 13 river and creek crossings on the Comox-Victoria segment; and
  - 4 river crossings on the Campbell River Lateral.

Detailed design for sections of the pipeline that may be installed by the directional drilling method must, on a site by site basis, give due regard to the geometry of the installation and the abnormal loads that may be imposed during pipeline installation and operation.

The major components of the land pipeline facilities have been adequately detailed during preliminary engineering design to form the design basis necessary for the preparation of project schedules, capital cost estimates and estimates of operating and maintenance costs. From a preliminary design basis, the Commission concludes that there is no element that would preclude the issuance of an Energy Project Certificate in response to PCEC's Application as amended and revised.

Design measures required to minimize the impact from forces of natural phenomena have been, and must continue to be taken by PCEC as it completes its detailed design and effects the installation of the pipeline. The Commission is comforted that the pipeline will be designed to operate through and after a design probable earthquake (an event with a return period of 100 years) and that it would likely not rupture but might suffer some damage in the event of a design maximum earthquake corresponding to a return period of 475 years (Exhibit 49, Hardy BBT Ltd.).

PCEC has stated that they are undertaking the preparation of a detailed seismic report (T 1113) which will be made available to the Commission. They have stated that the influence of seismic acceleration effects are quite insignificant. Any deficiencies noted in the Application in regard to the use of outdated information and compliance with the 1985 Revision to the National Building Code will be covered by the above-noted seismic report.

The Commission concludes that the pipeline design, completed by PCEC to date, and particularly the design and installation techniques considered for the crossing of environmentally sensitive rivers and streams, as submitted to contractors for bidding purposes on February 17, 1989, has incorporated all the essentials necessary to obtain competitive firm bids for the construction of the land pipeline facilities. It notes also that, while a substantial number of site specific designs will be prepared following a decision to proceed with the project, there is no additional design information of any significant nature required by the contractors that would materially improve the level of information needed to prepare and submit competitive bids.

2.4.4 Other Facility Design

Other facility design encompasses the design required for the initiating compressor station and its measurement facility, for the 23 meter-regulating stations, for the communication and telemetry facilities and for the two pipeline shops required for operations and maintenance.

Preliminary compressor station design has included siting studies, alternative driver considerations which resulted in the selection of industrial gas turbine drivers, the preparation of a preliminary site plan and schematics for the main gas, fuel gas, lube oil, air, cooling water and heating water systems. Westcoast previously completed the design of a station, very similar in nature to the initiation station proposed by PCEC. PCEC intends to adopt this design and modify it where necessary.

PCEC's compressor Station V-1 will be designed initially to include two 4100 kW units with provision to add three additional units in future years to maintain sufficient compression capability to supply market demands. The proposed design does not incorporate a spare compressor unit.

Two basic reasons were cited by PCEC to support its philosophy of not installing a standby compressor unit at any compressor station:

- Westcoast, in its operation of some 31 compressor stations on its system over about 30 years has maintained station and unit reliabilities in excess of 98%.
- PCEC, in the design of its pipeline transmission system, proposes to operate at the rated maximum discharge pressure of 14,890 kPa (2160 psig) from its compressor stations and to deliver gas to the end of its system at Victoria at pressure greatly in excess of that required for distribution.

Part of PCEC's rationale for selecting the 2160 psig system includes the consideration that flowing gas at higher mean pressures is more efficient and results in lower fuel consumption. As proposed, PCEC would deliver gas to Victoria, under peak day flowing conditions, at pressures in the range of 2000 psig in year 1 and 1200 psig in year 20. In the event that a unit outage occurs at Station V-1 (two units installed for year 1 and 5 units installed for years 14 to 20) PCEC would be capable of maintaining peak day deliveries to Victoria. Delivery pressure at Victoria would be maintained above the 500 psig contract commitment at Langford.

PCEC, in its response to the Commission's Information Request 1.2.5, provided assurance that it's compressor stations would be designed such that the level of noise and NO_x emissions would not exceed the standards established by the Energy Resources Conservation Board ("ERCB") of the Province of Alberta. The Province of British Columbia, and, in particular, the Municipality of Coquitlam, has not, in all instances, established guidelines for emission control. The ERCB standards are considered in general to be more restrictive and comprehensive than standards in other parts of Canada.

Preliminary design of meter stations has involved the development of a typical plot plan and schematics to cover the facilities required for the range of sizes of meter-regulating stations required for the proposed transmission system. On a peak day 20-year design basis, meter stations of varying sizes will be required to handle flow rates which range from a low of 0.2 MMScf/d (Texada Island) to a high of in the order of 50 MMScf/d (Victoria).

PCEC will, through discussions with the LDC's and the larger industrial consumers, determine site specific requirements for detailed design. PCEC advised that it would ensure the compatability of its installations with the requirements of each consumer. It further advised that since it would be installing line heating facilities necessary to increase gas temperatures prior to

pressure reduction, the cost of adding additional line heater capacity to accommodate LDC requirements would be minimal.

Preliminary design for the communications and telemetry, and for the operations and maintenance pipeline shops had been taken to the state necessary to ensure total system compatability and to provide the basis for developing schedules and estimated capital costs.

To date, detailed design with respect to the other facilities has not been initiated. The Commission is certain that PCEC is capable of designing these facilities to acceptable industry standards and will do so.

2.5 Operational Considerations

The PCEC plans for operating, maintaining and repairing the pipeline system are based on the Westcoast standards. These standards are based on decades of experience in the province and are in compliance with all codes and legislation.

Unlike the marine section of this pipeline project, the land pipeline poses no unusual concerns with maintenance of cathodic protection or emergency repair. When repairs are required in the vicinity of high-value fisheries streams or through watersheds, they will be done in collaboration with the appropriate agencies. This is discussed further in Chapter 4.

Pipeline patrol, leak survey, valve maintenance and right-of-way maintenance are all routine matters carried out by a combination of company personnel and contractors. PCEC has committed not to use chemicals for right-of-way vegetation control in the watersheds or near stream crossings.

In addition to routine inspections, an annual inspection is planned. This will be carried out by Westcoast's geotechnical staff and/or geotechnical consultants typically after the spring freshet season. Special inspections may also be carried out after extreme weather events. Particular attention will be paid to maintenance of rights-of-way in the vicinity of sensitive water crossings to ensure that erosion control work is adequate for fisheries protection and for protection of domestic water supplies.

The compressor station presents some special operating concerns related to air emissions and noise emissions. PCEC has assured the Commission that these will be considered in design to ensure that all applicable standards are met or exceeded. Monitoring, as required by Provincial Waste Management permits, will be carried out.

While the details of the Operating Agreement between PCEC and Westcoast have not been filed to date, the Commission in its ongoing regulation of PCEC will ensure that PCEC's plans for operation, maintenance and repair of land pipelines as set out in their operating agreements will be satisfactory.

2.6 Facility Construction

Land pipeline transmission facilities will be constructed by experienced pipeline contractors in accordance with governing codes, PCEC's construction and environmental specifications and proven industry practices. Facilities will be constructed by two basic types of contractors under conditions which are quite dissimilar:

- Cross country pipeline contractors, where the contractors work force progresses along the pipeline right-of-way, i.e. the site of work is a moving target which stretches the length of the total pipeline system.
- Facility type contractors, where the site of work is concentrated in one location.

2.6.1 Pipeline Construction

As proposed, PCEC's pipeline will be constructed in total, except for aerial crossings, by one or two major cross country pipeline contractors. Canada's major pipeline contractors, at any point in time, have, since the early 50's, numbered as few as eight and as many as a dozen or more.

PCEC has invited six major union contractors to bid the construction of the land pipeline portion of the Vancouver Island Gas Pipeline project. Most of the contractors invited are classified as both "big-inch" and "small-inch" contractors and many have constructed pipelines in British Columbia over terrain that in many instances has been much rougher and more demanding than that which will be encountered on this project.

Construction of the overland segments of the pipeline will involve a routine sequence of pipeline activities: clearing the right-of-way of trees and stumps; grading and levelling the right-of-way; excavating the pipeline trench; preparing and installing the pipe; backfilling the trench; pressure testing of pipe sections; cleaning up and grooming the right-of-way; and connecting the system into the gas supply.

Procedures and methods to be used for constructing the pipeline will be similar to those employed on other major pipeline projects in British Columbia. Fifteen to eighteen individual crews, sized with the appropriate complement of equipment and manpower to maintain a rate of progress in the order of 4 km per day, will move along the right-of-way in sequential fashion.

The rugged mountain terrain of portions of the route on the mainland, however, will require considerable rock blasting and rock removal to prepare a suitable right-of-way and to excavate a trench. Some of the rock work might be subcontracted. Crews established for clearing and rock work would work at a slower pace, well ahead of the main portion of the pipeline spread in most instances. Clearing, rock blasting and right-of-way grading could be undertaken during the winter in areas with favourable winter conditions. Some upgrading of existing forestry or powerline roads and minor new road construction may be necessary to provide access to the right-of-way for heavy equipment.

River and stream crossings will be constructed within the fisheries windows if flumed, dammed and pumped or open cut by a tie-in or river crossing crew. Directional drilled crossings installed under subcontract to the pipeline contractors, and aerial crossings, installed by a facility type contractor, would not be restricted to the fisheries window.

The most difficult to construct areas along the pipeline route include segments within the Coquitlam watershed, the upper Coquitlam River Valley, areas between Squamish and Woodfibre, the upper Woodfibre Creek Valley to Henriette Lake and portions of the Port Alberni Lateral.

Within the Coquitlam watershed, construction along the logging roads and the upper Coquitlam River Valley will be undertaken with a smaller than normal pipeline spread, in close cooperation with the GVWD and in compliance with the construction plan currently being developed by PCEC for GVWD Administration Board approval.

Construction from Squamish to Woodfibre involves a crossing of the Squamish River and a steep ascent (Squamish jump-off) from the east bank of the Squamish River to the rocky terrain above Howe Sound. Recent geotechnical investigation (Exhibit 49) at the river crossing location has confirmed that it is feasible to construct a conventional crossing and that no particular problems were noted which would prevent construction of a drilled crossing. A directional drilling contractor has advised PCEC that it is feasible. PCEC has encouraged its contractor to submit alternate bids but has also reserved the right to require the contractor to directional drill both the Squamish River and the Squamish jump-off.

The Squamish jump-off, if constructed by the conventional method of preparing grade, ditch, etc., does present a challenge. The slope is in the order of 35^{o} and certain equipment working on the slope might have to be anchored during installation. While it is a challenge on this project, pipelines in B.C. have previously been installed on much steeper slopes.

PCEC, in inviting six major union pipeline contractors to submit formal tenders for the construction of the land pipeline facilities of the project has provided the necessary documents to ensure that:

- Each contractor is fully informed of the nature and demands of the project.
- The contractor(s) selected from the competitive bidding process will construct the total land pipeline facilities (with the exception of aerial river and stream crossings) in complete accordance with the detailed:
  - scope of work;
  - notification procedures;
  - project specific environmental construction restrictions, cautions, and conditions;
  - corporate environmental standards and specific government agency requirements;
  - line lists;
  - alignment mosaics; and
  - specific and typical drawings.

Essentially, all of the terms and conditions with respect to the construction of the pipeline that could be imposed upon PCEC, have in fact been included in the bid documents. If additional terms and conditions, over and above those now included, are imposed by the Commission or by government agencies, the Applicant has given assurance that they too will be incorporated into the documents by way of Addendum prior to bid closing.

2.6.2 Other Facilities' Construction

The initiating compressor station, meter stations, pipeline aerial crossings, communications and telemetry facilities and the O & M pipeline shops will be constructed by facility type contractors.

Compressor Station V-1 will be constructed by a plant type contractor, experienced in the construction of a number of compressor stations for the Canadian gas transmission industry. The Commission believes that the site construction should probably include a berm or green belt around the perimeter of the site to aid in limiting noise emission.

Construction of the numerous meter stations is expected to involve the use of local area contractors to install prefabricated meter facility packages. The prefabrication would most likely be awarded to one or two fabrication contractors located in the larger centres.

Aerial pipeline crossings of rivers and creeks, in locations not selected for directional drilling crossings, will probably be constructed by local civil engineering contractors.

2.6.3 Conclusions

The Commission concludes that the pipeline construction of the land pipeline portion of the total transmission facilities, while moderately difficult in some areas, does not present any unusual degree of construction difficulty. It notes that PCEC, in its bid invitation to the pipeline contractors, has reserved the right to require directional drilling of a number of river and stream crossings and other difficult to construct areas, if feasible. The Commission urges PCEC to pursue this aspect with respect to environmentally sensitive crossings.

The Commission, following a detailed review of PCEC's bid documents, has assured itself that the bid package does contain the essential terms and conditions necessary to ensure the construction of the pipeline in an environmentally acceptable manner. It believes that PCEC can satisfy the Coquitlam watershed authorities that the pipeline can be constructed through its lands with minimum risk to water quality, and with mitigative plans and procedures in place to ensure minimum risk during construction. The Commission notes that PCEC has advised the contractors, in Appendix 5 of Volume 1 of the Mainland Contract bid document, that **"The Water District will have the right to stop the work whenever water quality of the water reserve is at risk as a result of the pipeline work."**

2.7 Schedule

2.7.1 Project Schedule

PCEC proposes, based on a project approval date of not later than April 1, 1989, to complete all detailed engineering and construction to meet an operational date of September 1, 1990. The project completion date was established on the basis of Westcoast's experience, in consultation with land pipeline contractors and with consultants experienced in the construction of marine pipelines.

A comparison of PCEC's proposed construction schedule, as presented in the "Preliminary Project Schedule" of its amended Application (Tab 7, Exhibit 10) and, the further refinement to a "Master Project Schedule" as provided within the recently issued bid documents, follows:

TABLE 2.7-1

Project Construction Schedule

Facility	Preliminary Project Schedule	Master Project Schedule
Marine Pipeline	- Jan.-Aug. 1990	July-Sept. 1989+ Dec. 1989 -July 1990
Land Pipeline		
- To Vancouver Island	May 1989-July 1990	May 1989-Jan. 1990
- On Vancouver Island	July 1989-July 1990	June-Oct. 1989+ Feb-July 1990
Compressor Station	Jan.-July 1990	Jan.-July 1990
Meter Stations	Mar.-July 1990	Mar.-July 1990
Communications - O & M	Aug.-Sept. 1989	Mar.-July 1990

Evidence was advanced during the hearings that the overall construction schedule is feasible, based on a project approval of not later than April 1, 1989, providing that a number of other agreements can be reached prior to the commencement of construction. PCEC advised that actual construction would not commence without:

- the Binding Agreement - Government of Canada - British Columbia Government - PCEC;
- the Industrial Agreements - COFI Individual Mills - PCEC; and
- the Gas Supply Agreements - Producers - PCEC.

In having invited tenders for the construction of the land pipeline facilities, PCEC has set a closing of 2:00 p.m. PST, April 18, 1989. This period allows two weeks to issue final addenda, to incorporate Terms and Conditions attached to the EPC. Following bid analysis, PCEC proposes to award construction contracts about May 1, 1989 for a May 8, 1989 commencement of construction.

A key element of the construction schedule is the operational date of September 1, 1990. Slippage in this date would undoubtedly affect the LDC's ability to tie-in the maximum number of consumers possible for the 1990-1991 heating season. Also key to preserving the September 1, 1990 operational date, is the requirement to commence construction early enough in 1989 to effect the installation of as many as possible of the river and stream crossings within the fisheries window, which, in most instances is mid-July to mid-September. Failure to install most of these crossings in 1989 would impede the ability to commission the land pipeline facilities in a prudent manner. The Commission notes that while slippage in any portion of the project schedule could affect the operational date, there appears to be less concern with the land pipeline than with the marine pipeline schedule in this regard.

2.7.2 Land Pipeline Schedule

The principle elements of pipeline scheduling encompass detailed engineering (design, drawings, specifications, input to bid documents and line location), contract documents (bid, analyze and award), material procurement, construction, testing, purging and start-up. The first three elements are commonly referred to as preconstruction activities, while the latter three are construction activities. Preconstruction activities involve that work necessary to allow commencement of construction on a segment-by-segment basis and may continue well beyond the commencement of construction of the initial segment.

Preconstruction activities associated with a land pipeline, necessary to the bidding process, have been essentially completed by PCEC. Upon award of an EPC, PCEC maintains that it would immediately commence those preconstruction activities (line location including land acquisition, further field investigations, drawings and submissions for all agency approvals, and the submission of plan, profile and book of reference) in a sequence necessary to enable Leave to Construct approval to be issued in an orderly and timely manner by the Provincial Chief Pipeline Inspection Engineer.

If, upon the issuance of an EPC, the Agreements precedent to a decision to proceed with construction referred to in section 2.7.1 above were not in place, it is most unlikely that the preconstruction activities that involve significant expenditures would be commenced immediately. PCEC, however, has laid the prudent groundwork necessary to the execution of these activities on the fast track schedule that it has proposed. It has:

- Commenced site-by-site river and stream investigations in cooperation with representatives of DFO and MOE.
- Established a Vancouver Island based lands and right-of-way office.
- Worked closely with many of the Provincial and Federal agencies to establish contacts and measures to assist in the review and approval of its required applications for permits, licenses and applications (Exhibit 20, Tab 2-B.11).
- Awarded contracts for the supply of project pipe and is in a position to award contracts for pipe coatings. Pipe can be manufactured, coated and delivered within eight or nine weeks of a notice to proceed.
- Positioned itself to award pipeline construction contracts as early as May 1, 1989.

The scheduling of land pipeline construction as portrayed by PCEC on its master project schedule provides for:

- Sensitive river and stream crossing installation within fisheries windows.

- Sequential construction of Mainland and Texada Island segments and Vancouver Island river and stream crossings in 1989 followed by the pipelines on Vancouver Island in 1990.

- The possibility of the award of the contract to a single contractor.

Evidence was advanced (Exhibit 56, p. 7) that there is ample time available within the overall land pipeline schedule to construct the proposed main transmission and lateral land pipelines to meet the operational date of September 1, 1990. Exhibit 61, a delivery schedule for pipe delivery based on an April 1, 1989 order, provided assurance that pipe could be manufactured at rates that would be required to supply the total project pipe for deliveries commencing July 1, 1989.

Contractors are capable of constructing the total land pipeline portion of the proposed project in a much shorter period of time than scheduled. During cross-examination it was pointed out that Interprovincial Pipeline's Norman Wells to Zama Pipeline, 850 km of 323.9 mm O.D. pipeline, was installed by two contractors in less than six months time. The scheduled production rate for welding, on an average work day as incorporated within the land portion of the Vancouver Island Pipeline project estimate, is about 4 km per day. Allowing for moves and downtime due to weather, one contractor, on his own, would be able to complete the main line welding in under five months.

It is the Commission's opinion that a delay in the commencement of construction by a month or so is unlikely to materially affect the pipeline contractor's ability to complete the land segments of this project by September 1, 1990. Work on the marine segments of the project is more critical to timely completion of the project.

2.7.3 Other Facilities' Schedule

The proposed schedules for the design, construction and start up of the compressor station, meter stations, communications and telemetry facilities, and the O & M pipeline shops are reasonable. Because of the complexity of the work, the schedule for the design and construction of the compressor station is closer to being on the critical path than any other land-based pipeline facility.

Based on advice from an independent review it requested, the Commission believes that any schedule slippage beyond a month or so in a decision to proceed with the project would in all probability put the compressor station on the critical path. Slippage beyond a month or so would be reflected in the operational date.

2.7.4 Conclusions

The Commission concludes that, overall, the proposed project schedule with respect to all of the land pipeline facilities is reasonable and achievable. It believes that it has been developed with due regard to the need to construct an environmentally acceptable system. The Commission accepts the requirement to install the environmentally sensitive river and stream crossings during this year's DFO approved construction windows and expects PCEC to comply.

The Commission understands the impediments that PCEC would encounter in its attempt to maintain a September 1, 1990 operational date if there were any significant slippage in the timing of project approval and in the timing of enabling agreements necessary to the decision to proceed with construction. The Commission has expedited the current hearing to the greatest extent possible consistent with the maintenance of fairness.

The Commission concludes that the timing of EPC, if this project is to move forward on the proposed schedule, is critical. It believes that any delay beyond mid-April 1989 will impact greatly on PCEC's ability to deliver gas on September 1, 1990. This is discussed further in Chapter 3 of this Decision in relation to the marine pipeline schedule.

2.8 Capital Cost Estimate

2.8.1 Filed Estimates - Land Pipeline Facilities

Initial estimated capital costs, in terms of thousands of 1989/90 dollars, for the land facilities of the "To Island" and "On Island" pipeline required for initial operation by September 1, 1990, are summarized in Table 2.8-1 below:

TABLE 2.8-1

Capital Costs - Land Pipeline

Facility	Direct Costs	Indirect Costs	Total 1989/90 Dollars
"To Island" Land Pipeline	$78,032	$14,483	$92,515
"On Island" Land Pipeline	67,929	10,727	78,656
Subtotal-Land Pipeline	145,961	25,210	171,171
Compressor Station V-1	11,944	2,108	14,052
23 Meter Stations	3,947	676	4,623
Communications & Telemetry	1,227	245	1,472
O & M Facilities	5,569	873	6,442
Subtotal Other Facilities	22,687	3,902	26,589
TOTAL LAND-BASED FACILITIES	$168,648	$29,112	$197,760

Direct and indirect costs for Subtotal - Land Pipeline, as tabulated above, are further detailed on Table 2.8-2. The detail shown has been taken directly from PCEC's capital cost estimates (Exhibit 3, Tab 12, Schedule A and from Exhibit 34, Schedule C). Supply and installation of line pipe represents almost 87% of the capital cost of all land based facilities. If the capital cost allowance included in O & M facilities for the "Submarine Pipe Repair Procedure and Equipment" is ignored, the figure increases to 89%.

2.8.2 Basis of Cost Estimates

PCEC prepared its cost estimates in consultation with contractors and consultants experienced in the construction of pipelines. The procedures adopted utilized well-accepted prudent practice. Project scope was first defined; preliminary routing, facility design, construction planning and project execution strategy were then developed to form the basis for estimating project capital costs.

TABLE 2.8-2

Detailed Estimate - Land Pipeline
To Island - 207.28 km - 273.1 mm
On Island - 212.40 km - 273.1 mm, and
74.63 km - 114.3 mm

Description	Thousands of 1989/90 Dollars		
	To Island ($)	On Island ($)	Total Land Pipeline ($)
Land & Land Rights	2,983	8,580	11,563
Materials:			
Type "A" and "B" Pipe	13,791	19146	32,937
Fabricated Assemblies	1,041	783	1,824
River Crossings	0	0	0
Road & RR Crossings	0	0	0
Internal Coating	1,131	1,211	2,342
External Coating	4,084	3,393	7,477
Miscellaneous Materials	152	212	364
Subtotal	20,199	24,745	44,944
Installation:			
Type "A" and "B" Pipe	37,103	20,702	57,805
Fabricated Assemblies	710	519	1,229
River Crossings	1,127	3,921	5,048
Road & RR Crossings	215	217	432
Weights & Anchors	82	101	183
Rock Ditch	11,578	5,148	16,726
Field Radiography	456	476	932
Miscellaneous Construction	156	209	365
Subtotal	51,427	31,293	82,720
Start-up & Test Heads	315	376	691
Inspection	3,108	2,935	6,043
TOTAL DIRECT COST	78,032	67,929	145,961
Engineering & Overhead	1,952	1,698	3,650
Omissions & Contingency	9,994	6,982	16,976
AFUDC	2,537	2,047	4,584
TOTAL CAPITAL COST LAND PIPELINE	$92,515	$78,656	$171,171

Land Pipeline Cost Estimates

- **Land & Land Rights**

  These are estimated costs to acquire land in fee simple, to obtain easements, to pay damages, and to carry out location survey for final route and for legal survey after pipeline construction. Estimates were derived with input from land appraisers and legal surveyors.

- **Materials**

  Estimated costs for permanent materials including transportation to stock piles, were derived from material quotations obtained from suppliers and manufacturers. Written quotations were received for well in excess of 95% of the total value of direct material costs.

- **Installation**

  Costs were estimated for all installation, testing and purging of the complete pipeline. Cost estimates were developed in parallel from contractor's estimates, and from in-house engineering department estimates based on Westcoast's previous experience. The project design basis was provided to each contractor for the development of his portion of the installation cost.

- **Start-Up and Test Heads**

  These are estimated costs for placing the permanent facilities in operation. Test heads are utilized during testing of the pipeline, but are not part of the permanent installation.

- **Inspection**

  These are estimated costs for PCEC's field construction- management and inspection during construction. Estimates were developed based on the number of personnel, vehicles, other support, subsistance, etc., required for the construction duration.

- **Engineering and Overhead**

  These costs were calculated at 2.5% of direct costs based on previous Westcoast experience.

- **Omissions and Contingencies**

  These are estimated costs resulting from the inclusion of specific and general unanticipated contingency allowances.

Other Facility Cost Estimates

Cost estimates for compressor Station V-1, 23 meter stations, communications and telemetry, and O & M facilities (total of approximately $1,665,000 without marine pipeline component), were developed in a manner similar to pipeline cost estimates. Installation costs were based on Westcoast's historical costs for similar type facilities.

2.8.3 Monte Carlo Analysis

In response to the Commission's Information Request 1.4, Tab 1, Exhibit 20, PCEC submitted the results of a risk assessment derived from Westcoast's proprietary risk-analysis program. The program employs the Monte Carlo technique to simulate project capital cost variations and to report distribution of results from up to 1,000 cost simulations. The analysis, undertaken in response to the request, employed about 40 parameters which were assigned individual risk profiles. The results of the risk analysis on land pipeline cost estimates were as follows:

- "To Island" - 92.6% probability that the actual costs will be less than the estimated cost of $92,515,000.
- "On Island" - 98.0% probability that the actual costs will be less than the estimate cost of $78,656,000.

Input to the risk analysis for land pipeline included PCEC's estimator's judgement with respect to the highest and lowest realistic value, the best estimate, and a confidence profile for quantities and costs related to major components of the estimate. Most parameters selected for the analysis involved the dollar value for the major cost elements shown in Table 2.8-2. Parameters selected for quantity analysis included grade rock and ditch rock. A situation assuming that the pipeline on Vancouver Island would lie idle for six months (AFUDC would increase) due to a delay in completing the marine segment was also included in the analysis.

Evidence extracted during the hearings with respect to the input to the analysis, and the limitations of the technique, as applied by Westcoast led to the perception that the probabilities of the actual costs of the land pipeline being less than the estimated costs were overstated. That is, the probabilities of the project coming in under budget were overstated.

The factors that contributed to the sense that the probabilities were overstated included:

- The Monte Carlo risk analysis had not been applied to the Vancouver Island project prior to a Commission information request that PCEC quantify a level of confidence that the project could be completed on schedule, at or below the estimated cost;
- Situations with respect to the effect of schedule slippages were not fully explored;
- The particular technique has not been regularly employed by Westcoast or by other companies; and
- Probability profiles were arbitrarily determined rather than being based on historic records of earlier experience on other pipelines in comparable terrain.

2.8.4 Historical Variances

Evidence was advanced by PCEC relative to Westcoast's actual experience of estimated vs. actual pipeline costs based on the period 1971 to 1986. For this period, the following data was provided:

- Actual Expenditures - $240,978,000;
- Estimated Costs - $270,243,000 (in submissions to the National Energy Board); and
- Variance - approximately 30,000,000 or 10.8% under budget.

The above data does not highlight individual under or over expenditures. Through cross-examination it was determined that Westcoast's actual experience included a number of major pipeline projects:

- 236 miles of 36" loop in one year (1971);
- the 110 miles, 24" - Beaver River Pipeline; and
- the Grizzly Pipeline, the one that did include substantial amounts of rock.

The Grizzly project had been estimated at about $44 million. Approval for the project, anticipated for the first of the year, did not materialize until about mid-February. The contractor lost about half of the three month winter construction season and was required to carry on after break-up through unfrozen low lying wet areas. Westcoast had estimated the contractor's inconvenience at about $3 million, however, arbitration awarded the contractor $8 million. The arbitration award resulted in a final project cost of about $52 million, a 15-20% cost overrun.

Westcoast, in 1982, had been involved in the Pacific Northern Gas Ltd. Expansion Project to serve the Ocelot plant at Kitimat. Westcoast's initial capital cost estimate was in the order of $28 million. Actual costs incurred were in the order of $42 million, significantly over the estimated costs. Labour disruptions which occurred during the implementation of the work contributed to the overrun.

The above examples illustrate that while Westcoast's estimating record is generally good, it is certainly not flawless. This history needs to be considered in the current project assessment.

2.8.5 Cost Variances - Land Pipeline

PCEC's filed capital cost estimate was extensively probed by intervenors and the Commission Counsel. Many points were raised in an attempt to find weaknesses within individual components of the estimate. PCEC remained adamant that the capital cost estimate as filed, represented a sound estimate and there was a very low probability that the actual costs would exceed the estimated costs providing that project certification would be available in time to permit a May 1, 1989 bid award.

At the onset, PCEC advised that it had awarded a firm contract for the supply of project pipe at a fixed price, significantly under budget, that carried through for all of the material required for 1989 and 1990. It further advised that it had firm price quotations for internal and external pipe coating. This, then, would represent a firm price for over 95% of project materials or about 29% of the estimated total direct costs.

The most subjective portion of estimated total direct costs are the installation costs. As estimated, they represent about 57% of the estimated total direct costs. Considering the omissions and contingency category, without regard for the significant project savings that would flow to the category from the material component now firmed-up, installation costs could be increased by 20% and still allow the project to be completed at the estimated total capital cost.

Evidence was advanced by COFI's consultant (Exhibit 58) that PCEC's estimated direct costs for installation of the land pipeline could rise substantially due to a number of factors:

- Pipeline construction activity is on the increase.
- There are fewer contractors and less equipment in Canada now as compared to five to ten years ago.

- Contractors' overhead and profit expectations could rise to the 15-25% range.

- Productivity had been over estimated by PCEC. It should be reduced to 80% due to the very difficult terrain involved and the inherent problems associated with access along narrow rights-of-way in many locations.

PCEC, in preparing its estimate and in the steps it has taken since submitting its Application, is confident that actual costs have a very low probability of exceeding its estimate. PCEC takes this position because it:

- Very carefully defined its project requirements prior to enlisting the contractor to prepare its detailed crew-by-crew estimate of installation costs.

- Obtained two estimates from the same contractor; one at project agreement reduced labour rates, and one at mainline union rates in effect in December 1988.

- Incorporated escalation, on total estimated installation costs from 1988 to 1989, and from 1989 to and 1990, at 7.5% per year.

- Has a Project Agreement, arranged by the Pipe Line Contractors Association, and the principal unions. It assures that there will be no strikes, no wobbles, no slow-downs, no work stoppages and in addition, contains certain concessions that will ensure productivity.

- Has, within its estimate, rock quantities which closely correlate with those of its geotechnical consultant and the contractor who prepared detailed installation estimates.

- Feels strongly that the evidence that was led with respect to the possibility of reduced productivity, should it occur (and PCEC does not believe it will occur), was overstated and that it should have been applied consistent with the reasoning advanced. It was applied to the total installation costs but should have been applied only to a maximum of 45% (rock grade, rock ditch) of the to-Island portion of the pipeline.

If one took the combined effect of an increase in "Overhead and Profit" expectations to the 20% level, and the very unlikely possibility of a "productivity rate decrease to 80%" (properly applied), the net increase to installation costs would be roughly 12%, still well below the 20% net available contingency figure discussed above.

The resourcefulness of the contractors has been solicited by PCEC in its bid invitation. The tender call is based on the award of the project under two contracts. Contractors are asked to suggest a reduction if awarded both contracts and/or if proposing a later completion date. Joint ventures and alternate proposals as to methods and pricing are also invited.

2.8.6 Conclusions

The Commission concludes that there is a high probability that the land pipeline facilities can be constructed at or below the estimated capital cost, providing that PCEC is awarded an EPC on or soon after April 1, 1989 and provided that the necessary agreements for the decision to proceed with construction are executed prior to the end of April. A delay much beyond the end of April would begin to impact PCEC's costs. The Commission believes, strictly from the perspective of land pipeline cost, that these project costs would not increase significantly with a one to two month timetable slippage.

CHAPTER 3 MARINE PIPELINE FACILITIES AND CAPITAL COSTS

3.1 Introduction

This chapter deals with the marine crossings of the Strait of Georgia and Malaspina Strait.

The Terms of Reference dated December 20, 1988 require the Commission to assess, among other things, design and construction of the crossing, and the Applicant's ability to complete the project on time and on budget. The purpose of this chapter is to assess:

- Marine Routes;
- Minimization of potential service interruptions;
- Construction Methods;
- Scheduling;
- Maintenance and Repair;
- Engineering; and
- Costs.

Insofar as PCEC's main crossing of the Strait of Georgia follows the general alignment proposed by Westcoast at the 1983/84 hearing before the Commission, the following extract from the Commission's June 1984 Decision is worthy of repetition (p. 227):

> "The Commission finds that on the basis of the evidence presented to the Hearing, Westcoast and B.C. Hydro are both capable of providing safe, reliable natural gas service to meet the market demands on Vancouver Island and for a Fertilizer Plant at Powell River. The Commission has determined that no unacceptable socio-economic or environmental impacts would result if proper design and construction timing are followed. The Commission reached these decisions after exhaustive examination of the competing proposals, particularly the environmental aspects of pipeline construction and operation."

3.2 PCEC Proposal

PCEC proposes to transport natural gas to Vancouver Island through dual 273.1 mm O.D. pipelines across lower Malaspina Strait and the northern Strait of Georgia. The pipeline will extend, through dual lines, from Wood Bay near Secret Cove on the Sechelt Peninsula across Malaspina Strait to the south part of Texada Island. It is routed north as a single line on Texada Island then crosses the Strait of Georgia with dual lines from the north end of Texada Island to a point near Little River on Vancouver Island. A dual 273.1 mm O.D. lateral line is proposed that will cross from the north end of Texada Island to Powell River. PCEC refers to the Secret Cove/Texada Island crossing as the southern crossing. The other two are referred to as the northern crossings.

The southern crossing is 11.8 km in length and is about 400 meters deep at its maximum depth. The Little River/Texada Island crossing is 23.4 km and reaches a maximum depth of about 355 meters. The Texada Island/Powell River crossing is 8.9 km long and reaches about 150 meters maximum depth at the location surveyed. Until recent years the extreme depth of the water was the major obstacle to building these pipelines. However, in 1980 the first of three 508 mm O.D. gas transmission pipelines was completed across the Mediterranean Sea between Tunesia and Sicily in over 600 meters depth. A pipeline of comparable depth to the Strait of Georgia was laid in 1983 across the Norwegian trench in the North Sea, and petroleum production lines have been installed in the Gulf of Mexico in depths to about 460 meters. There is therefore little question that the submarine pipeline crossings can be built for the Vancouver Island Natural Gas Pipeline. No evidence was presented at the current hearing to dispute the technical feasibility of the submarine pipelines.

A number of marine surveys have been conducted by various applicants in the area of the northern crossings. PCEC in their present Application has adopted the earlier work performed by Westcoast for the northern crossings (Exhibit 3, Tab 2). The southern crossing is proposed for the first time in the present Application. Therefore, in 1987 PCEC conducted a limited marine survey in the area of the lower Malaspina Strait. None of the areas of the crossing sites have been surveyed and studied in exhaustive detail, but this is not normally considered necessary at the feasibility study stage of a project. The purpose of the marine survey, at this stage, is to explore the sea bottom until a route is located along which it is possible to install a pipeline, and then identify the geologic and oceanographic features along that route that affect construction methods and cost. It follows that in stopping the search when the first suitable route is found, it remains entirely possible that a better and less costly route can be found with more intensive exploration.

3.3 Routing

3.3.1 Northern Crossings

3.3.1.1 Marine Survey

The earlier marine survey work performed by Westcoast was reviewed extensively in the 1983 Commission hearings. The results of the 1981 survey made in preparation for the 1983 Application are included in Exhibit 35, submitted during the 1989 Commission proceedings. In the 1981 work, areas were searched for a route directly between the Comox area and Powell River, and for a route that would cross the north end of Texada Island. The direct route across the Strait of Georgia between Little River and Powell River was eventually selected.

For basic information on waves, currents, winds, etc., Westcoast utilized information developed for similar feasibility studies performed in 1966 by Bechtel and in 1972 by Fluor (see Commission 1984 Report). Review of these reports revealed that the usual local public sources were researched to develop the required information. The data used is adequate for feasibility studies provided a margin for errors is considered in the preliminary design, in cost estimates and in the construction timetable.

A marine hydrographic survey was carried out in which acoustic instruments were used that also served the purpose of assisting in geotechnical studies. The work was performed by Can-Dive. Twenty-two soil borings of limited penetration were taken. No borings were taken in the shore approach areas, only surface grab samples. Since no additional work was undertaken on the northern crossings since 1981, it is still uncertain whether rock will be encountered in the shore approaches when excavating. The Fluor, Bechtel and B.C. Hydro reports indicated the presence of rock at the shore approaches.

For PCEC's design of the pipeline coating, it is exceedingly important to know the characteristics of the surface of the sea bottom. Both the Bechtel and Fluor reports indicated rock outcrops were encountered. The Can-Dive report also indicated this possibility. During the 1981 survey, Westcoast found it necessary to visually confirm certain features on the sea bottom. For this purpose, Westcoast used a Remote Operated Vehicle ("ROV"). The ROV transmitted a video movie to the surface vessel and recorded the information regarding the sea bottom on video tape. The video evidence does not cover the surf-zone areas, where most rock would be expected.

The geotechnical evidence presented at the hearing by geologists of the Department of Energy, Mines and Resources concluded that there is an earthquake potential in the Strait of Georgia which is traversed by at least two major fault zones (Exhibit 41).

The Commission therefore concludes that:

- The marine surveys conducted to date are adequate for feasibility study purposes;
- Rock outcrops and boulders exist in the shore approaches; and
- Earthquakes are a potential hazard.

3.3.1.2 Route Selection

The route investigations leading to the 1983/84 hearing emphasized searches around the north end of Texada Island and in the area south of Harwood Island near Rebecca Rock. The selected route started at a point on the mainland between Powell River and Westview then followed a line approximately straight from shore and lying just south of Rebecca Rock to a point roughly in the middle of the Strait. From there it followed a gentle curve then changed to a straight line into Little River. Its total distance is about 32 km. The sea bottom falls to about 260 meters depth about 7 km from Westview, then it rises to about 60 meters depth about 10 km out, near Rebecca Rock. Proceeding west the bottom then descends to about 355 meters maximum depth at the point where the route turns somewhat to the north.

The same route has been adopted by PCEC for the 1988 Application. It varies from the earlier proposal to the extent that an underwater manifold and valving arrangement would be installed at a point south of Rebecca Rock. The purpose of the underwater manifold is to accommodate the changed route for the main line which now crosses the lower Malaspina Strait and continues northward on Texada Island and thence to Vancouver Island instead of being routed directly to Vancouver Island from Powell River.

Three options for the connection at the north end of Texada Island have been considered (Volume 7, Tab 4) by PCEC that will affect the final route selection. Two of the options, designated 'A' and 'B', require the pipeline to be routed on the 1.5 km unexplored section. Option 'C', which would place the

manifold on shore, is a major departure from the proposed routing. In PCEC's testimony (T 6) it is inferred that a feasible route has not yet been found that would make Option 'C' a viable solution. In cross-examination this was confirmed. However, other testimony pointed to the 1981 survey report (Exhibit 35, Diagram 1-201) which shows the area for Route 'B' was extensively explored at that time.

In any case, PCEC does not consider any route found to be completely final. However, they did consider the corridor selected as being satisfactory and indicated that final routing would be very close to it.

The Commission concludes that the general route selected for the northern crossings is feasible, but believes that greater attention should be paid to the location where the route appears to cross the major fault zone to avoid the steepest part of the submarine slope which is believed to form the east side of the fault displacement. The Commission recommends that PCEC work with the Federal Department of Energy, Mines and Resources to develop its detailed studies.

3.3.2 Southern Crossing

3.3.2.1 Marine Survey

The southern crossing was surveyed for pipeline study purposes for the first time as part of the present Application.

The marine survey performed is considered by the Commission to be adequate for feasibility study purposes. The first potential route explored was apparently abandoned because of vertical rock faces 10-40 meters in height on the steep submarine slope found in the approach to Texada Island, and a potential long span at the base of the slope where the angle between the slope and the bottom is 15-25^{o} (Volume 7, pp. 2-13). The survey was moved about

2 km to the north, near Anderson Bay, where the approach to the Island is still very steep but the vertical rock faces are limited to 4-8 meters. At this second location a sediment lens provides a transition from steep rock slope to flat lying basin sediments.

In general, the steep rock slope at Texada Island was found to extend to a great depth with slopes of 35-45° (Volume 7, pp. 4-19) and averaging 41° on the approach to the Island (Volume 7, Drawing 203).

The survey used side scan sonar as an effective means of locating large boulders and rock outcrops on the east side of the crossing but the sonar was of little value on the west side. However, by using other acoustic instruments in combination with the side scan sonar a reasonably good evaluation of the sea bottom was made for the full length of the crossing, within the limits of such instruments.

The sea bottom can be described as being rough and rocky for 1 km from the eastern shore to about 20 meters of depth, then fairly smooth and sediment covered with probable scattered large boulders out about 8 km, then steeply sloping unstable sediments sloping down to the deepest part of the Strait. The deep section reaches a maximum depth of about 400 meters and is mostly silt, sand and plastic clays. The lower western slope has a thin sediment layer over rock up to about the -230 meter depth, above which it is apparently solid rock with three or four vertical rock faces.

A 1968/69 Current Measurement Program (Exhibit 48, Tab 4) which was conducted by the Federal Government hydrographic service close to the proposed pipeline route provides valuable information. Currents used in hydrodynamic calculations are considered adequate for the feasibility study. Winds were researched through local records. It can be noted that the strongest winds occur in the winter and spring months, which is to be expected. Perhaps more importantly, northwesterlies to which the launch site is exposed, predominate.

The Commission concludes that the marine survey conducted by the Applicant, taken together with available information is adequate for feasibility study purposes, although significant additional work is required for final design.

3.3.2.2 Route Selection

PCEC describes the route selected as having several curves (Volume 7, pp. 1-3) to avoid significant rock outcrops and boulders. Drawing 302 (Volume 7) shows only two long gentle curves which may be deceptive when considering the fact that numerous large boulders are known to exist and in light of the description of the terrain referred to above.

From the description of the route there will definitely be rock excavation on both shore approaches. Large boulders along the route on the seabed surface will pose a problem for final routing. Buried boulders may exist that will interfere with any means of excavation other than blasting. Currents, swift enough to cause serious problems during installation, do not appear to be present, although attention will need to be given to the hydrodynamic stability of the pipe on the sea bottom in the near shore areas.

The Commission concludes the route selected is satisfactory for planning purposes.

3.4 Facility Design

3.4.1 Design Criteria

For the most part, accuracy of the design criteria at this stage of a project is not critical to the objective of specifying a reasonable cost estimate. For this reason it can be stated that most of the design criteria established in Exhibit 35 is sufficient for ordinary feasibility study requirements.

However, the construction method selected, on which cost of construction is based, is extremely dependent on accurate design criteria for currents and conditions of the sea bottom. Because of this, it would have been preferable to have these items more accurately defined. The only alternative is to make allowances in the form of cost adjustments to the capital cost estimates to cover a wider range of variables. The Commission concludes that design criteria are adequate, provided sufficient margin for forced changes and delay is allowed in the cost estimates.

Design for a marine pipeline is closely related to the characteristics of the route and to installation method. Almost every design factor for any given pipeline can be varied within certain limits to accommodate a particular installation method or situation regarding the route. Pipe wall thickness and grade, coating type and thickness, diameter and number of lines, are usually the factors that are manipulated. If strong currents are expected then weight must be added to the pipe to provide hydrodynamic stability. The Applicant has demonstrated a clear understanding of these options.

PCEC appears to have made an early decision that the bottom-tow method of installation was likely to result in the lowest cost. After sizing the line they apparently started with the bottom-tow method of installation and worked backward to adapt the pipeline to the method, and after that adjusted it to the environment. Therefore, the bottom-tow method is the basis for design, construction planning, and cost estimates. The Commission accepts the concept that a single competitive construction technique can be used to develop costs that will form the basis of a budget estimate for the project. However, since alternative methods will be examined during tendering, it must be clear that all potential costs are identified and included in the estimate.

3.4.2 Design Requirements of the Bottom-Tow Method

The bottom-tow method proposed involves welding up the pipe on shore in long sections or strings of 300 meters each. One or more large tugs are hooked to the end of the first string which is then dragged into the water. When that string is in the water, the second string is welded to it. Then the tug pulls both sections out, another string is welded on, etc., until the full pipeline length has been towed into place. The amount of pull force required is proportional to the weight of the pipe so that the key factor in design of the pipeline is to carefully control the weight so that it is less than the total amount that can be pulled by the tug selected.

Calculation of the force required to tow the pipe along the bottom is quite simple. The force required is a product of the unit submerged weight of the pipeline, times the length, times a judgement or "pull" factor related to friction. PCEC has assumed the friction factor will be 1.0 and supplies evidence to support this assumption (Exhibit 36). It is important to understand that this factor is not a safety factor. For the pipe to be used in this project a variation in the weight per foot by one pound on the positive side will increase the total pull force required by 20%.

PCEC proposes, prior to construction of the submarine pipelines, a series of pipe towing tests to accurately determine the actual longitudinal and transverse towing friction factors.

The minimum pipe weight that can be tolerated is dependent on the amount of negative buoyancy (weight of pipe and coating submerged in water) that is required to hold the pipe on the sea bottom when it is subjected to hydrodynamic forces, or to buoyancy forces. For a pipeline these forces are resisted by friction between the pipe and the sea bottom. This is created by the negative buoyancy of the pipeline. Negative buoyancy can be adjusted to a desired effective weight by specifying a pipe wall thickness which will produce

the required weight from the steel in the pipe. Usually it is too expensive to use steel to obtain desired weight so a concrete coating is applied instead. Although the principal reason for a concrete coating is usually for weighting purposes, it also provides mechanical protection for the pipe's corrosion coating. If the weight of the pipe resulting from the extra steel and/or concrete is too great to allow the pipeline to be towed, the weight can be reduced by adding buoys to the welded pipeline string before the pull. They must be removed after installation is complete. Since the use of buoys can be expensive and since they can be lost during the tow (increasing the pull force required), their use is avoided as much as possible.

For the bottom-tow method proposed for the present Application, the Applicant has had to strike a balance between weighting the pipeline so that it would be heavy enough to withstand the hydrodynamic forces but light enough so that it could be towed by the tugs available on the West Coast.

It is a widely accepted concept in the pipeline industry that a pipeline being dragged over rocks or hard surfaces should have some mechanical protection for the corrosion coating on the pipe to prevent it from sustaining abrasive damage. This can be accomplished with application of a high density, high strength concrete or silica-filled epoxy coating. PCEC proposes to eliminate the usual abrasion-resistant coating in a long section of the northern crossing. They maintain there are no rock outcrops in the selected route and consequently there is likely to be little abrasion and, in any case, they plan a test program in which sections of pipe will be dragged over the sea bottom. The test pipe will be coated with various types of abrasion-resistant coating and unprotected fusion bonded epoxy. If, from the tests, PCEC concludes that its proposed fusion bonded epoxy corrosion coating will not satisfactorily resist damage, they will use one of the abrasion-resistant coatings tested (at additional cost). Even though it may be correct that there are no rock outcrops, there is a great deal of evidence pointing to numerous boulders and

cobbles that could have an abrasive effect. Should PCEC be forced to fall back on a concrete coating, this will add weight, and as already noted, the addition of one pound per foot adds almost 20% to the total submerged weight of the pipeline. To install the pipe without an abrasion-resistant coating appears to be a high risk design feature. While it is possible that field tests may eventually confirm the validity of reduced protection, for feasibility study purposes there is enough evidence that the Commission believes the cost of full abrasion-resistant coating should be included in the current estimates.

Another problem with weight involves the steel pipe itself. No steel pipe can be manufactured where all the joints of the pipe have the precise wall thickness desired, consequently, manufacturing tolerances are allowed. In answer to Information Request 2.1.1(iii), PCEC submitted a pipe specification that limits manufacturing tolerances to -3% and +7%, effectively cutting the potential weight variation by about one half. Additionally they believe the pipe mill will target the weight to be between -0.5% and +3%, and that the average weight of several hundred joints will be between 0 and +2% of the targeted weight. This may be acceptable for use with the bottom-tow concept where the pipe will have an abrasion-resistant coating. It should be possibly to closely control the weight when the final coating is applied, however, it can only be used to add weight rather than to subtract. Therefore only underweight can be corrected this way. For pipe without such coating the weight probability assuming +2% variation is about one pound per foot overweight. This must be considered in calculating the pull force, even if the pipe is covered with abrasion coating.

For the present Application by PCEC the most critical crossing from the standpoint of the bottom-tow concept is the Little River/Texada Island crossing. The length is 23.8 km of which 4.15 km are proposed to be coated with an abrasion-resistant coating, leaving 19.65 km without such coating.

Based on PCEC's numbers the maximum tow force requirement for the Little River/Texada Island crossing has been calculated to be 193.2 metric tonnes. If one pound per foot is added to the pipe to account for the possible average overweight of the uncoated pipe, then the tow force required is 193.2 plus 35.4 or 228.6 metric tonnes. This exceeds the rated bollard pull of the tow tugs provisionally selected by PCEC by 14%. Buoys must be added to the pipe to make the method work, larger tugs must be used, or the friction coefficient must be demonstrated by towing test to be less than 0.875.

If, in addition to the overweight adjustment, abrasion-resistant silica-filled epoxy coating is added to the full length of the northern crossings then the tow force has been calculated to be 305 metric tonnes at a friction factor of 1.0 (see Table 4.2.1). This weight must be reduced to at least the amount that the two tugs can handle, and preferably to one tug (T 584), by placing buoys on the pipe.

PCEC has proposed using two tugs for the tow, each generating 100 tonnes bollard pull for a total available of 200 metric tonnes (Volume 7, pp. 5-7). Assuming these tugs are available, it is necessary to determine how much of the available power can actually be applied to towing the pipe. In the tandem towing concept there is concern that the prop on the second tug may not get a full bite. Information Request 2.1.1(v) asked for more information on this. PCEC's response included letters from two towing companies, both of which recommended parallel instead of tandem arrangements, for the two-tug configuration. Both towing companies indicated in their letters that they did not have enough information to fully evaluate the job. The Commission concludes from this that some downrating of the bollard pull is in order to compensate for unknown factors. It makes sense also to downrate the bollard pull to allow for ageing of the vessels, a certain amount of mismatch in their power, and also the fact that power would be applied at an angle to the direct line of force required for the pull. For estimating purposes, the Commission suggests 80% of rated bollard pull may be appropriate.

Assuming 200 tonnes of rated bollard pull, downrated at 80% to 160 tonnes, then for the tow of the Little River/Texada Island crossing, the weight of the pipeline might need to be reduced by as much as 145 tonnes at a friction factor of 1.0.

Table 3.4-1 summarizing the tow force and buoy requirements under this conservative scenario, follows:

TABLE 3.4-1

Summary of Required Tow Force

	Length km	Feet	Submerged Unit Wt.	Weight Pounds	Tow Force Tonnes F = 1.0
Proposed	19.65	64468	5.00	322340	146.2
	4.15	13615	7.61	103610	47.0
	23.8	78083	-	425950	193.2
Overweight	23.8	78083	1.00	78083	35.4
				504033	228.6
Add Full Abrasion Coating	19.65	64468	2.61	168261	76.3
Total Weight				672294	304.9
Bollard Pull at 80%				352800	160.0
Wt. to be reduced with buoys (maximum)				319494	144.9
Buoy Requirements (@ 1000 lb. lift each)					319.5

The Commission concludes that the two tugs proposed by PCEC may be inadequate to guarantee that the pipe as finally designed can be pulled, and that buoys may be needed on the pipe to make the tow. A suitable allowance should be made in the cost estimate until such time as actual friction factors are established by tests and the resulting towing forces are confirmed to be feasible by the towing contractors.

3.4.3 Other Design Factors

Other factors such as earthquakes, soil liquefaction, span, vibration, collapse, propagating buckles, etc., have been considered to the extent necessary for feasibility studies. Some adjustment to pipe wall thickness is already proposed and further adjustments may be necessary in final design.

In the earlier hearings (1983) it was demonstrated that earthquake induced liquefaction of the soil may take place in the area of the northern crossings. Westcoast pointed out, correctly, that small areas of liquefaction of the size expected would not be harmful to the pipelines. Earthquakes could also cause instability of the soil on a steep slope. This subject was also explored thoroughly in earlier proceedings. Stability concerns are mitigated by orienting the pipe alignment parallel to the direction of potential flow that would occur in the event of slope failure. Resulting stresses in the vertical plane of the pipe were shown not to be excessive. PCEC has used the same approach with this potential problem at the slopes on Texada Island where the sediment layer is comparatively thin. PCEC's solution in the present case is considered acceptable, should the pipe be eventually laid on the surface in this area and secured with mechanical anchors.

Lateral movement of the seabed at fault crossings during a seismic event is unlikely to create problems for the pipeline which is free to move relative to the seabed at the deep water locations.

A problem which could develop because of an earthquake, is overstressing at points where the line is restricted, such as at the underwater tie-in manifold proposed by PCEC for the north of Texada Island or where the lines enter the seaward end of the back-filled trench at the shore approaches. The shore approaches can be designed to withstand the seismic forces but protecting the underwater manifold would be more difficult.

The Commission recognizes that the risk of earthquakes is an unavoidable hazard but is confident this matter will be dealt with by PCEC in its final design. The Commission does not favour the underwater manifold connection proposed for installation north of Texada Island.

3.4.4 Burial Near Shore Approaches

PCEC proposed to bury the pipelines on the northern crossings from the shoreline to a depth of -110 meters. For the southern crossing they proposed to bury or otherwise secure the pipe to the -60 meter depth on the west side of Malaspina Strait. On the east side of this waterway pipe will require stabilization down to -30 meters (Exhibit 9, pp. 3-6). Excavation is planned to be done by blasting and by clamshell dredge from 0 to -20 meter water depth. Beyond -20 meters it is planned to use a specially designed plow.

Pipelines are usually buried to protect them from external damage by dragging anchors or fishing trawls. Burial can also protect a pipe from swift currents on the sea bottom. In the present case, the pipe is unstable on the seabed above 110 meter water depth in the northern crossings at the designed weighting proposed. For the southern crossing where the measured currents are lower than the northern crossings the pipe may also be unstable down to the -60 meter depth on the western side of the channel (this portion is solid rock on the Texada Island slope).

To solve this problem, PCEC proposes pre-trenching or other forms of stabilization. Pre-trenching is a satisfactory solution to the problem but is expensive.

In view of the evidence presented during the 1984 proceedings, including that of other Applicants besides Westcoast, the Commission recommended that pipe burial extend only to the -15 to -20 meter water depth. Information Request 2.1.1(v) asked for confirmation that the design would be changed in this regard. PCEC responded that they would leave this matter for final design. They confirmed that the pipe was unstable above -60 meters on the western side of the southern crossing. Also it was admitted that the plow cannot be used on the Texada Island slope so "other methods" of stabilization will be needed (T 647). Any final analysis will need to focus on trenching versus stabilization using additional coating for weight; anchors; or dredging. Trenching by plow requires a project with a considerable amount of trenching to make it cost effective compared to other means. This is because of the fixed cost of design, fabrication, and testing of the plow. In response to Information Request 2.2.2(iii) PCEC submitted a breakdown of these costs. The Commission doubts that the plow will be cost effective in the present case, particularly since it cannot be used on the Texada Island slope. In all probability it will not be feasible at Powell River because of large boulders, or at the north Texada Island approaches because of rock.

In the direct evidence (T 481), PCEC states that the -110 meter depth design (1981) was overly conservative and that it should be reduced considerably. They did not accept the -20 meter depth solution and said it would be re-evaluated in final design. In cross-examination (T 650) they agreed that the plow would not seem to be cost effective and that it had originally "made sense" because of the -110 meter bury requirement at the northern crossings.

The Commission concludes that the use of plow and its development cost should be deleted from the cost estimate and provision made for alternative means of pipe stabilization to the depths determined necessary in final design.

3.5 Operational Considerations

3.5.1 Corrosion Protection

A long life for the pipeline is dependant on the design of the cathodic protection system, minimization of coating damage during construction, and careful monitoring of the system after construction. The cathodic protection system can consist of anode bracelets bonded to the pipe, an impressed current system or a combination of both. PCEC has proposed only the anode bracelets method of protection although they state the impressed current system will be studied in final design.

Many submarine pipelines are protected only with the anode bracelets. Anodes have a definite predictable life span after which normal corrosion of the pipe will ensue. This can be satisfactory for offshore oil and gas pipelines where a definite life span requirement can be predicted. Corrosion detection tools ("smart pigs") are also available to monitor the extent of corrosion from year-to-year. The Vancouver Island Gas Pipeline will need to be protected for an indefinitely long life. Therefore, anode protection alone will not be enough because the anodes will not be replaceable at reasonable cost in the water depths involved.

The extent of cathodic protection required is a function of the number of imperfections in the protective coating and the amount of damage done to the coating during construction. The design of cathodic protection systems for marine pipelines is not an exact science. For onshore systems much depends on periodic measurements taken in the field. Even then pockets of corrosion can go undetected for long periods. The safest course for marine pipelines is to provide a superior protective coating to begin with then and minimize damage during construction. This is even more important in rocky areas because rock impingement is a well known cause of corrosion spots.

Marine pipelines that are laid on a rocky surface should have an outer coating of hard material to protect the corrosion coating. Usually a concrete coating serves this purpose, and the silica-filled epoxy proposed by PCEC will probably be satisfactory, subject to field tests. A pipeline laid by barge over a few rock outcrops would probably not sustain enough damage to the corrosion coating to effect the corrosion protection. However, dragging the pipe over the same rocks could cause unacceptable damage to the corrosion coating and possibly to the anodes attached to the pipe.

PCEC does not believe that significant rock exists on 19 km of the route between Little River and Texada Island. The evidence submitted in 1984 did not support this contention.

The Commission concludes that regardless of the outcome of the proposed marine survey planned for early 1989 the pipe should have an external abrasion-resistant coating if the bottom-tow method of construction is used, in order to ensure the integrity of the exterior corrosion protection coating.

3.5.2 Hazards

Anchors of large vessels and fishing trawls are a potential hazard to marine pipelines. This is not expected to be a problem on this project because there is no local anchoring activity by deep sea vessels and because of the extremely deep water over much of the route. In any case the installation of dual lines separated by a suitable distance is an effective safety feature to safeguard against this eventuality. The only exception to this is where the lines are installed in close proximity to each other at shore approaches and where the proposed underwater manifold occurs (section 3.6.5). On the other hand, small anchors from sport fishing vessels can cause damage to the corrosion protection coating on the pipe, unless the pipe is buried through shallow water areas. This will be the case here, except possibly on the steep Texada Island south approach. An anchorage prohibition should be posted for this area if the pipe is eventually anchored on the surface of the slope.

3.5.3 Maintenance

PCEC plans to follow what is good practice for the maintenance of critical marine pipelines by providing for periodic visual inspection using a submersible. Little maintenance is expected to be required. There may be light scouring in shallower waters that could increase pipe spans but this will be easy to correct. Comparisons of the video tapes used for visual inspection should be made from year-to-year to evaluate any changes. PCEC should give consideration to distinctive exterior marking of underwater surface-laid pipe to facilitate annual correlation of video records.

Corrosion surveys should also be made at the time of the visual inspections. PCEC has made provision for launching and receiving barrels to be installed for the purpose of running corrosion detection tools.

The Commission concludes that the maintenance program planned by PCEC for the submarine pipelines will be satisfactory.

3.5.4 Repairs

The chances that the marine pipelines proposed for this project will need repair are extremely low. Damage to the line in the deepest waters is almost impossible to conceive of other than due to a catastrophic earthquake. With proper non-destructive testing of the pipe before construction, x-ray of the welds during construction and a good corrosion protection system, as planned by PCEC, there should never be a failure. If there were a failure then the time and cost of repair would depend on the depth of water where the damage occurs. The deeper the water the more time consuming and costly the repair. Considerable advances have been made in the technology of deep water repairs in recent years. PCEC's marine consultant, in cross-examination, outlined the difficulties and some recently developed methods for recovery of a severed pipe end from deep water. The Applicant expressed its intention (T 616-620) to explore repair options as an alternative to stockpiling sufficient pipe to replace a complete pipeline crossing.

PCEC has proposed a system of dual pipelines in the marine crossing as a safety measure in the event of a pipe failure. During cross-examination, PCEC expressed concern that, in later years, when the pipeline is expected to be operating near full capacity, a problem could develop because of a temperature drop in the gas should all demand be supplied through a single line. At the request of the Commission, the temperature dynamics were reviewed by a third party engineering firm which gave the opinion that this condition would not create a problem.

The Commission concludes that the dual system, which provides 100% redundancy in the marine crossings, provides sufficient service assurance to provide time to work out an acceptable repair program.

The Commission concludes that stockpiling sufficient pipe for the replacement of the longest northern crossing is an unwarranted expense and that having dual lines at both northern and southern crossings should afford sufficient assurance of service reliability. This assurance will be further enhanced if the manifold and valving associated with the dual northern crossings are located on-shore at Texada Island where they will be readily accessible at all times.

3.6 Facility Construction

3.6.1 Configuration Options

For the marine portions of the pipeline, PCEC has three optional facility configurations ('A', 'B' and 'C') for the northern crossings and their interconnection. It is proposed by PCEC that the final construction plan will be deferred until completion of new route surveys. The Commission believes that only options 'B' or 'C' at the north end of Texada Island should be considered for construction since either of these schemes places the manifold valving on shore where it will remain accessible for fast response in the event of emergency problems on either the northern main submarine line or the Powell River submarine lateral.

For the southern crossing, the final plan is proposed to depend on the outcome of a study of the feasibility of directionally drilling a J-tube configuration for the approach to Texada Island as an alternative to slope preparation by blasting and securing of pipe by mechanical means.

With respect to the difficult south Texada Island shore approach the Commission urges PCEC to undertake an early geological assessment and test coring to permit solicitation of bids on the directionally drilled J-tube concept before a commitment is made to the open slope blasting. The J-tube concept avoids the many potential hazards associated with securing the pipeline by mechanical means on a steep slope, subject to possible harmonic vibration from vortex-shedding due to high currents, and subject to potential debris slides from shallow surficial sediment deposits overlying the rock both above and below sea level. In addition, the J-tube solution has the advantage of removing the slope preparation from the "critical path" where blasting of the slope would otherwise be placed because of fisheries window limitations. Similar limitations will almost certainly not apply to the directional drilling.

With reference to possible vortex-shedding around the open anchored pipe on the south Texada Island slope, it is imperative that additional current measurements be made over the full depth range, as close to the rock slope as practicable, to determine, with assurance, whether currents of sufficiently high velocity are actually present, in the event that the open slope solution has to be adopted.

3.6.2 General

Each of the crossings will have five basic categories of construction work. These are: (1) blasting, dredging and otherwise preparing the route for pipe installation; (2) pipeline installation; (3) manifold and connection; (4) correction of spans after pipe installation, backfill, and clean-up; and (5) testing, drying and start-up.

3.6.3 Blasting, Dredging and Route Preparation

This work can be performed at any time it is possible to schedule it prior to installation of the pipe. The blasting work will be subject to stringent controls and restricted scheduling by the DFO. A ban on blasting between November 15 and June 1 is anticipated in PCEC's schedule. Very difficult blasting will be required in the deep water on the south Texada Island slope unless the directionally drilled J-tube solution is adopted. For the open slope blasting, PCEC proposes to use shaped charges as much as possible which should have the effect of confining the sediment and debris, normally associated with blasting, to a much smaller area.

PCEC proposed to use blasting coupled with clamshell dredging at the shoreline and near shore area down to about -20 meter water depth where this type of dredging is most effective. There is no technical reason why the pipe paths, other than those on the south Texada Island approach, cannot be properly prepared to receive the pipe using a combination of blasting, dredging, filling and diver assistance.

On the Texada submarine slope PCEC suggests the use of anchors to hold the pipe in place against compressive and hydrodynamic forces. However, the precise installation method will not be decided upon until final design. For the alternative concept of directionally drilling the shore approach more detailed geological information than that currently available is necessary.

3.6.4 Pipe Installation

PCEC has selected the bottom-tow method for purposes of feasibility study and cost estimating. However, they have stated in Volume 7 of the direct evidence, and in cross-examination, that they will invite bids from qualified contractors proposing any acceptable technique. They consider that the lay barge, the reel barge, the bottom pull and the bottom-tow are all acceptable means of installing the pipe.

There is no single "best" method for constructing a marine pipeline. In most cases two or three methods are acceptable. The choice is usually based on price, contractor competence and experience, and equipment availability.

The lay barge is the most versatile method and the least disruptive of onshore areas since large pipe make-up sites are not required. Using this method, there would be no need to clear and grade large onshore work sites at Little River, Wood Bay and, possibly, Powell River. All three methods require careful design of the pipe but the lay barge method is the most adaptable to a wide range of design solutions. Consequently, most marine pipelines are installed with a lay barge, including the world's two deepest installations. There are only five potential bidders having the necessary equipment to bid this method.

The bottom pull is the next most popular system. This method uses a large winch and cable and sometimes an intervening barge to pull the pipe across the seabed. It is the oldest method in use today. Almost all river crossings were installed by bottom pull until the advent of the drilled crossing in recent years. There are many contractors that can use this method.

The reel barge is an acceptable means of installing smaller diameter pipe as on the present project. However, there is only one active contractor having the appropriate floating equipment.

The bottom-tow method is similar to bottom pull, but has seen limited use in the past mostly because there were no tugs large enough to exert the pull force needed to move the pipe. This has changed in recent years and a number of large tugs have been built for the offshore oil and gas industry. There apparently are no established marine contractors actively bidding this concept at the present time. However, most marine contractors have the capability of using the method if they see a competitive advantage in it.

PCEC recognizes that it is in the best interest of the project to maintain competition by considering any of the above-described methods proposed by a financially and technically responsible bidder.

3.6.5 Manifold and Connections

The underwater manifold and valving proposed at the north end of Texada Island, if used, would be installed by divers. There is no reason why it should not be installed satisfactorily as many underwater connections of this nature exist in various oil fields of the world. On the other hand, such installations present a constant maintenance problem and are a source of potential leaks. In general, underwater systems should be avoided unless there is some extraordinary financial penalty to the alternative. The Commission therefore believes Option 'A' embodying the underwater manifold should not be considered further, as stated in section 3.6.1.

All other manifolds, valves, trap and crossover piping between the dual lines are fairly routine and will be fabricated and installed in a conventional manner.

3.6.6 Corrections to Spans, Backfill, Clean-up

After the pipe is installed, the lines will be inspected by ROV to locate any excessive spans that could cause the pipe to overstress when filled with test water. These spans will be reduced to an acceptable length by either placing rock fill under the line from surface vessels or filling beneath the pipe with diver-placed structures or grout bags. Any of these means are acceptable. Such operations are likely to be impractical on the southern approach to Texada Island in which case blasting will be required prior to pipe placement unless the directional drilling alternative is employed.

3.6.7 Testing and Start-up

These activities will be performed in a routine manner commensurate with the land pipeline requirements.

The Commission, while recognizing the difficulties of working in deep water, and the heavy reliance which this places on remote position fixing and surveying, concludes that the construction plan proposed by PCEC is feasible although it is likely to severely test the project's schedule constraints (TR 930).

3.7 Schedule

3.7.1 Factors Affecting Schedule

The period in which the project must be designed and built is dictated by the date of issuance of the EPC presently expected by the Applicant on April 1, 1989. The marine project needs to be completed by September 1, 1990 to coincide with completion of the land pipeline. This leaves a total of 17 months to build the submarine portions of the project.

A schedule for a marine pipeline project is normally built around a "weather window" for the most favourable sea state conditions. Heavy seas and strong winds can in some cases shut a job down and in most cases tend to slow the work and multiply equipment problems by placing undue stress on the various types of rigging. The best time to work on the water in the northern Strait of Georgia would be in the late spring, summer and early fall, but the overall period of time available for the execution of the project does not permit much freedom in timing the work to get the best weather window.

Another important consideration that affects scheduling is the construction method that will be used. Other matters materially affecting scheduling will be the decision as between options 'B' and 'C' for line location at the north end of Texada Island, and timing of underwater blasting to accommodate requirements of the DFO.

The detailed schedule for the marine crossing is shown in Exhibit 9 (Drawing 601, Volume 7). The basic marine activities are also shown on the overall project schedule in Volume I of the Application. The Commission believes that the schedule, as proposed, will require the full 17 months available to complete.

3.7.2 Scheduling of Marine Surveys

The marine survey is extremely important to the job and is on the critical path. The time allocated for the marine survey appears reasonable, however it is noted that the first four weeks are allotted to planning. Considering the amount of time already spent in preliminary work for this project it should be relatively simple and inexpensive to do the planning work prior to the issuance of the Certificate. PCEC, in fact, has suggested during cross-examination that they may do this (T 932). If work is pre-planned in this manner, four weeks can be saved in the schedule and the critical survey program advanced by this amount.

3.7.3 Scheduling of Underwater Blasting

In answer to Information Request 2.3(i) (Exhibit 20) PCEC submitted three schedules that make it apparent that the underwater blasting required cannot be performed in the preferred June/July period without serious delay to projection completion. However, by advancing part of the route selection activity and altering the contracting procedure it is possible to put a contractor in the field to do this work beginning in mid-July through about mid-September, 1989. Such a schedule requires urgent advancement of geological studies and calling of tenders for the J-tube directional drilling at the south end of Texada Island, if a meaningful comparison with open slope blasting is to be obtained.

Preparation of the south Texada Island approach by blasting is scheduled for 46 days (Exhibit 20, Information Request 2.2.2). The Commission notes from Exhibit 37 that this item is subject to the greatest estimated cost variation of all items on the whole project. The Commission believes this reflects the complexities of the task and its potential for serious schedule delays. This serves to emphasize the importance of proper evaluation of the directional drilling alternative.

3.7.4 Effects of Installation Methods

Use of the lay barge method offers some additional time savings on the overall schedule. If the lay barge is used, the pipe make-up site work and the welding of pipe strings are eliminated from the schedule. However, shoreline pipe trench preparation, subject to fisheries windows, remains a problem. In response to Exhibit 20, Information Request 2.3(iii), PCEC submitted a work schedule for the lay barge. When comparing the lay barge installation time to the bottom-tow schedule it appears theoretically that the project could be completed in 13 months, if the preferred weather window were to be ignored and if fisheries restrictions were not applied to shore crossing works. In reality, the Commission believes that shore preparation work must still be done in the 1989 fisheries window for on-time completion by the lay barge method.

3.7.5 The Weather Window

The importance of the "weather window" cannot be over emphasized in scheduling construction and in selecting the construction method. In gale force winds most construction activity will come to a stop, mainly because auxiliary vessels, work boats, pipe barges, tug boats, dredgers, diving support vessels and survey boats must cease activity and/or seek shelter. This effectively stops construction. In the Strait of Georgia, the prevailing winds and waves will be abeam which will aggravate the problem. Doubtless, the tow will have to be discontinued in such conditions. If the tow must stop for an

extended length of time, scour and siltation can take place around the pipe line on the sea bottom which may make it extremely difficult to start moving again. For a lay barge, wind load and wave load during poor weather could force the work to stop because of anchor displacement.

The reel barge might be less susceptable to weather delays than the lay barge or bottom-tow method because it can be more selective in timing the pipelaying periods. However, it is questionable that the time saved will be substantial.

The method which would have the least likelihood of weather delays would be the bottom pull using a cable and shore based winch.

During cross-examination, PCEC expressed its view several times its view that the weather in the region of this project is "benign" in terms of its effect on construction operations (T 479). The weather picture outlined in Exhibit 4, Volume 2, Tab 6 tells a somewhat different story for the late fall, winter and early spring when many water-based operations must be executed. In the winter (December - February) there is a pattern of frequent passage of frontal systems through the area producing gale force winds over 54 km/hr.

From Exhibit 4 it is apparent that gale force winds could move through the area three to five or more times per month during the winter/spring period. Considering that the front might affect the area for as much as two days, there is a potential weather downtime of six to ten days per month. Add to this, the weaker fronts which move through the area with a similar frequency, and the two or more days of work disruption because of fog (Figure 4.6-1), and a troubling picture of the potential weather downtime results for the months from October to mid-April. On the other hand, the summer and early autumn months appear to offer minimal chance of weather downtime.

In the present schedule (Drawing 601), the near shore bottom preparation work is planned for February and March. The work requires a barge mounted clamshell dredge, dumping of rock fill, diving, underwater blasting, utility vessels and survey boat. All will be subject to periodic shutdown in the winter and early spring storm and fog scenario.

The tows are scheduled in April and May and will involve use of tugs, utility vessels, barge with an ROV, auxiliary vessel and survey boat. The weather is in transition at this time to the summer pattern but modest delays can still be expected to all operations during April.

It is questionable how much would actually be gained if the schedules were shortened to move the construction period to an earlier date. However, an early start of the marine survey offers the opportunity to move the near shore bottom preparation from an unfavourable period in February and March of 1990 (when fisheries restrictions may well apply) to a favourable weather window in July, August and September of 1989 when restrictions are less likely.

In regard to scheduling, the Commission concludes:

- There is a degree of risk that the marine project will not be completed on schedule, delaying in-service date to December 1990. The consequences of such a delay are harsh, including not only AFUDC but the larger financial liability of lost load during the first year of operations.

- An early start on planning the marine survey is urged in order to advance the date of underwater blasting of shore approaches to the 1989 fisheries window. Moving as much of the near shore bottom preparation as possible to the summer of 1989 would be beneficial to the project.

- Early successful tendering of the directional drilling J-tube option for south Texada Island could eliminate that part of the underwater slope preparation most subject to delays and help ensure maintenance of the proposed September 1990 in-service date.

3.8 Capital Costs

3.8.1 Analysis of PCEC's Estimate

PCEC prepared a cost estimate based on the information available from the preliminary marine survey, preliminary design, and the proposed construction plan. The starting point was the estimate made in 1981, included in Exhibit 35. The costs in Exhibit 35 were updated to 1987. Since Exhibit 35 only covered the northern crossings, an additional estimate was prepared for the lower Malaspina Strait crossing. The sum of these costs are presented in Volume 7, Tab 5. After the costs were summarized, PCEC then escalated the costs to the 1989-90 period and presented these numbers in Volume 1 of the Application. A summary of the escalated costs as presented in the Application, with slight revisions resulting from information requests, follows:

TABLE 3.8-1

PCEC's Estimated Submarine Pipeline Costs
- Bottom Tow (1989/90 Basis)

	$(000's)
Land and Land Rights	676
Materials	12,021
Installation (including Mobilization & Demobilization)	24,661
Engineering and Field Engineering Services	4,299
PCEC Overhead & Engineering	1,626
TOTAL FACILITIES ESTIMATED COST	43,283
Allowance for Omissions and Contingencies	5,792
AFUDC	1,446
TOTAL PCEC ESTIMATED MARINE PROJECT COST	50,521

3.8.1.1 Materials

The material component of the above Table 3.8-1 breaks down as follows:

TABLE 3.8-2

Materials Costs - Bottom-Tow

	$(000's)
Pipe	7,085
Internal Coating	520
Corrosion Coating	1,331
Abrasion Coating	1,903
Anodes	299
Fabrication	883
TOTAL	12,021

The quantities of materials required will vary in final design, but except for the abrasion-resistant coating, none of the quantities is expected to change significantly. The abrasion-resistant coating could vary substantially in final design depending on the results of towing tests.

PCEC has not included abrasion-resistant coating in the estimate for about 19 km of the Little River/Texada Island crossing. In response to Information Request 2.1.1(i) they submitted the amount of $1,330,360 as the additional cost for the type of coating they would use if it were required.

The Commission has considered the evidence on this matter and concludes that the additional coating should be used when the bottom-tow method is employed and that the cost for this additional item should be included in the estimate. It was also brought out in cross-examination that abrasion-resistant coating would not be required for the full length of any of the crossings if the lay barge or reel barge were used. In these cases, it was agreed that a length of one kilometre at each shore approach (p. 751, Volume 5) would be sufficient for estimating purposes. A concrete coating would be used for shoreline areas if the pipeline was constructed by lay barge and that concrete would be 50-75% cheaper than the epoxy/silica coating presently in the estimate (p. 756, Volume 5). The reel barge however, would still require a flexible abrasion-resistant coating at the shore approaches.

In regard to the cost of material the Commission concludes that:

- The presently estimated cost of pipe is adequate, considering the favourable bids already obtained from the pipe mills (T 158).
- The cost of additional abrasion-resistant coating for the entire crossing length should be included in the Little River to Texada Island crossing.
- Abrasion-resistant coating is required at all shore approaches even if lay barge or reel barge is used.

Considering the conclusions, the Commission estimates the material costs based on construction method, as follows:

TABLE 3.8-3

Material Cost Comparison - Alternate Methods of Installation

	Bottom-Tow/Pull $000's	Lay Barge $000's	Reel Barge $000's
Pipe	7,085*	7,085*	7,085*
Int. Coating	520	520	520
Corrosion Coating	1,331	1,331	1,331
Abrasion Coating	3,233	68	136
Anodes	299	299	299
Fabrication	883	883	883
TOTAL AMOUNT	$13,351	$10,186	$10,254

*Does not include pipe stockpiled for emergency repair.

3.8.1.2 Installation

Installation costs as shown in the PCEC estimate, based on the bottom-tow method, are listed below (Exhibit 3).

TABLE 3.8-4

Intallation Costs - Bottom-Tow

	$(000's)
Make-up Site Preparation	1,870
Pipe String Make-up	3,920
Tow String Launch	1,432
Tow	5,380
Diving (Span Correction)	1,334
Shore Approach Construction	5,542
Trenching and Backfill	3,134
Testing and Pre-Commissioning	526
Radiography (x-ray)	174
Insurance	1,349
TOTAL AMOUNT	$24,661

Overhead and Mark-up

A review of the detailed estimates in Appendix "C" of Volume 7 indicates a high level of effort in compiling labor, equipment, indirect materials and mobilization costs on a task-by-task basis. The Commission believes that these estimates may be deficient with regard to overhead and mark-up. Overhead and mark-up are not set out separately but are included in labour and equipment rates (Exhibit 9). It would appear that nothing has been included for such overhead items as general supervision, construction engineering, time keeping, port captains, office space, helicopters, small boats, local transportation, communications and a myriad of other smaller costs since they are not expressly mentioned. However, such costs are normal to the execution of a project of the size and importance of the present one. The Commission believes these costs may run as high as 25% of direct field costs.

A contractor's mark-up covers his risk and general office overhead as well as profit. The Commission understands from its marine consultant enquiries that risk is sometimes assessed at about 50% of labour costs plus one or two months equipment rental costs on major marine projects. Considering these items usually leads to a mark-up factor of about 20% of estimated field costs. Unfortunately, there is no way of knowing, from the evidence presented, the extent to which this cost has been incorporated in the individual items. The Commission believes that an additional allowance of 22.5% should be added to the pipe installation costs (first seven items of the Installation Costs shown in Table 3.8-4).

Mobilization and Demobilization

Mobilization and demobilization costs (for the bottom-tow method) are included in the costs of each task (detailed in Appendix "C", Volume 7). These have been extracted and summarized. The total cost allowed is $462,000. This assumes two days for tugs coming from the West Coast. If the tugs are 20 days distant, say from the Gulf of Mexico, the cost increases about another $433,000, to $895,000. The range of costs then is $462,000 to $895,000. Considering the likelihood of needing tugs larger than those proposed by PCEC as discussed in section 3.4.2 above, the Commission believes an additional $433,000 should be provided in the budget for Mobilization and Demobilization.

Plowing Costs

The costs of using the plow to do trenching are also buried in the cost estimate. In response to Information Request 2.2.2(iii), PCEC submitted a summary of these costs. They are:

TABLE 3.8-5

Plowing Costs

	$(000's)
Design	210
Fabrication	350
Operation	1,176
TOTAL	1,736

It is fairly clear from the cross-examination that the plow is not a cost effective solution for pipe stabilization in the near shore areas (T 650). It has no other useful purpose. Although stabilization in the form of additional weight on the pipe will be required in the near shore, this can be accomplished with concrete coating or nominal increase in the epoxy/silica coating. This will add marginally to required towing force. Therefore, the Commission believes the entire cost of using the plow can be eliminated from the cost estimate. With stabilization obtained by additional weight coating, there may be no need for burial of the pipe below the -20 meter water depth.

Added Buoyancy

As discussed in section 3.4.2 above, the tugs PCEC has assumed for the tow may be pushed to the limit of their power capability on the northern crossings between Little River and Texada Island. The cost of buoys is discussed in PCEC's response to Information Request 2.2.2(iv). The cost per buoy can be derived from this to be $3,449 each. Depending on the final pipe weight, 319 buoys may be required to offset the weight of the extra coating on the pipe at a towing friction factor of 1.0. The cost of 319 buoys is about $1.1 million.

Weather Downtime

Weather downtime was discussed in section 3.7.5. Even though it now appears that the offshore work will be largely done in April and May, it appears prudent, for feasibility study purposes, that an allowance of about 10% should be made for weather downtime regardless of the method used.

Conclusions on Installation Costs

In regard to installation costs the Commission concludes that:

- For estimating purposes a factor of 22.5% should be added to selected costs (the first seven items in Table 3.8-4).
- Mobilization and demobilization costs estimated for the bottom-tow method are overly optimistic and an adjustment in the amount of $433,000 should be provided to allow for use of larger tugs not headquartered in the Pacific Northwest.
- Costs for design, fabrication, testing and operation of the plow can be eliminated from the cost estimate in the amount of about $1.7 million.
- The cost of buoys to be placed on the pipe for the Little River/Texada Island crossing during towing should be included in the cost estimate at $1.1 million.
- For feasibility study purposes an allowance of 10% should be included in the cost estimate for weather downtime during the offshore operations.

3.8.1.3 Engineering and Field Services

These activities will be performed directly or supervised by PCEC's engineering consultant. They are indicated in Table 3.8-6:

TABLE 3.8-6

Engineering and Field Services Costs

	$(000's)
Route Survey	1,302
Project Management, Design and Procurement	776
Construction Management	1,318
Permitting and Certification	627
Specialized Development	276
TOTAL	4,299

Route Survey

The Route Survey costs were not detailed in PCEC's Volume 7. No breakdown was made available in response to Information Request 2.4(ii). No further information was developed in cross-examination. However, the $1.3 million allowance is believed to be adequate.

Project Management, Design and Procurement

Project Management, Design and Procurement covers the work done by PCEC's marine consultant, mostly in the first five months of the project, to complete the design and contract documents. The cost allowed appears adequate.

Construction Management

Construction Management, as the term is used here, is inspection and engineering field supervision of a contractor's work. The Commission believes that the allowance is adequate for inspection and field engineering services provided contracts are largely awarded to a single major marine contractor or consortium.

Specialized Development

Specialized Development includes $210,000 for design of the plow. For reasons discussed above, it should be deleted. This results in a revised total for Engineering Costs of $4,089,000.

3.8.2 Revised Cost Estimate

3.8.2.1 Revisions and Comparison

Based on the Commission's conclusions enumerated above, it is recommended that the PCEC cost estimate for the marine portion of the pipeline be adjusted to the total presented in Table 3.8-7 below:

TABLE 3.8-7

Revised Cost Estimate - Bottom-Tow

	Revised Amount $(000's)	
Land & Land Rights	676	676
Materials		
Original Estimate	12021	
Add Abrasion Coating	1330	
Materials Cost	13351	13351
Installation		
Original Estimate	24661	
Deduct Plow Costs	(1526)	
Add Possible Buoy Costs	1100	
Add 10% Weather Downtime	2219	
Add 22.5% Overhead and Mark-up	4992	
Add Mobilization/Demobilization Adjustment	433	
Amount	31879	31879
Engineering		
Original Estimate	4299	
Less Plow Design	(210)	
Amount	4089	4089
PCEC Expenses	1626	1626
Total Estimated Facilities Cost		51621
Contingencies		4171
AFUDC		1446
TOTAL PROJECT COST		56668

The following Table 3.8-8 summarizes and compares the revised estimate with the original:

TABLE 3.8-8

Comparison of Cost Estimates - Bottom-Tow
($000)

	Original	Revised
Land and Land Rights	676	676
Materials	12021	13351
Installation	24661	31879
Engineering	4299	4089
PCEC Expenses	1626	1626
Estimated Facilities Costs	43283	51621
Contingencies	5792	4171
AFUDC	1446	1446
TOTAL PROJECT COST	50521	57238

3.8.2.2 Conclusions

The Commission concludes that the cost of the marine portions of the project, using the bottom-tow method, could exceed PCEC's estimate by about $6.7 million.

The Commission believes from its evaluation of the alternative methods that there is a good chance the lay barge method will offer a competitive price for the project. If so, it will keep the risk of widely fluctuating bids under control.

The Commission strongly believes that it is important for the marine costs to be budgetted conservatively since by the time the marine contract bids are received there will be very significant sunk costs in the land pipeline construction activities. At this stage of the project surprise increases in cost would be untenable.

3.8.3 Other Cost Matters

3.8.3.1 Powell River Lateral

PCEC has proposed that the crossing from Texada Island to Powell River be constructed with 273.1 mm pipe. The load at Powell River does not justify this size pipe. Information Request 2.1.3 requested that the proper size be calculated and the cost saving be estimated. The PCEC response indicated a reduction of $600,000 based on 219.1 mm pipe but stated that this savings was offset by the cost to stockpile the new pipe size and the cost of additional repair tools.

In cross-examination (T 856) in answer to a previous suggestion that 114.3 mm pipe would be adequate for the Powell River Lateral, PCEC replied that the savings would be only $400,000. The reason given for this was that the wall thickness of 114.3 mm pipe would have to be increased to keep the tensile stress in the steel pipe below acceptable limits during the towing of the pipe. With the increase in steel in the pipe the weight also increases requiring that buoys be added to the pipe to reduce the weight to the point it can be managed by the towing power (bollard pull) available. This is correct for the bottom-tow or bottom pull method but does not apply to the lay barge method or the reel barge method. Therefore, in comparing costs for alternate methods, there could be a much more substantial saving in pipe cost for the Powell River Lateral if the lay barge or reel barge were to be the method used. This should be taken into consideration in the final decision on award of construction contracts.

The Commission believes the minimum savings from using 114.3 mm pipe for the crossing versus 273.1 mm may be about $900,000. There will be some additional savings in the cost of coating and welding. The Commission does not believe this modest saving would justify the limitation placed on future expansion at Powell River and therefore accepts PCEC's design proposal.

3.8.3.2 Costs of Repair

In Schedule 12 of Volume 1, PCEC has included a cost of $4,130,000 for a stockpile of pipe equivalent to the length of the longest crossing, as well as expensive repair clamps, and construction equipment. It seems reasonable that repair clamps and special tools could be long lead time materials that should be kept on hand. In line with the Commission's conclusion in section 3.5.4 that stockpiling pipe for the replacement of the longest crossing is unwarranted, the costs for this pipe should be deleted from the cost estimate. The Commission does not believe this change is significant enough to warrant a reduction in total project budget at this stage of design.

CHAPTER 4 ENVIRONMENTAL & SOCIO-ECONOMIC CONSIDERATIONS

4.1 Introduction

4.1.1 Impacts

The Vancouver Island Gas Pipeline project will have impacts on the land and aquatic environment throughout its length of 536.6 km, thereby affecting present and potential resource activity in the area. Fisheries, water, wildlife, recreation, tourism, heritage, agriculture, forestry and terrain resources will be affected to varying degrees throughout the route.

With respect to the aquatic environment, the project will cross in excess of 162 rivers and streams and will require the construction of five beachheads for the marine segments of the pipeline. Many of these rivers and streams, particularly on Vancouver Island, have high natural fisheries values and several of them have fisheries enhancement facilities in place which have added to this value. Recreational use of these streams and rivers by sports fishermen is high. Water quality downstream of the pipeline crossing may be affected by construction, thereby possibly influencing domestic use. Of particular note, is the location of the proposed route within the watersheds of Greater Vancouver and Greater Victoria.

4.1.2 Benefits

In the area to be serviced by the Vancouver Island Gas Pipeline, pulp mills, light industrial facilities and boilers and furnaces in commercial, institutional and residential facilities often burn oil. This is the case for all coastal pulp mills which will be served by the natural gas pipeline and, particularly true for many residences on Vancouver Island.

The burning of oil has been recognized for many years as a significant source of sulfur emissions into the air.

It is evident that by conversion to natural gas, sulfur emissions into the air will be significantly reduced. In this regard, environmental issues related to the ecological impact of acid rain and associated pollutants will be reduced, thus, providing a positive step in environmental management.

In addition, the need to transport oil to Vancouver Island and coastal locations will be significantly reduced. This will reduce the potential for oil spills on the environmentally sensitive coastline in this area of British Columbia.

4.2 Socio-Economic Impacts

4.2.1 Summary of Issues

It is estimated that 90% of the content of goods and services used in the project will be Canadian (T 1250). Pipe for example is to be manufactured by a Canadian supplier (T 1280), Steel Co. of Canada (T 1376). The specialized areas of expertise such as the marine crossings require equipment and skills unavailable in Canada.

The size of the work force will vary with the segment and stage of the pipeline construction. In the construction timetable of 77 weeks (Exhibits 50 and 60), developing 1509 work-years of employment, the crew size ranges from 50 to 425 people (T 1904-1905). The land contractors will be from Alberta and will bring their key personnel (T 1251-1252). The Applicant estimated that approximately 55% of the labour force will be from this province (T 1285).

The work crews will reside in the local communities as the pipeline is being constructed and may be widespread as required by specific areas (T 1253). There is a possibility that a construction camp will be located on Texada Island to accommodate 50 people and serve as a staging area for the marine crossings. Squamish would be the desirable location for a second camp to provide for a base of operations for construction near the coast (T 1255). A maintenance crew of approximately 18 people would reside permanently in the communities along the route and operate the system (T 1254).

In the opinion of the Applicant, the project itself will generate a significant tax base for the local communities that should more than offset the social burden imposed by the permanent work force (T 1260). The property tax assessment is estimated to be about $1.32 million per year (T 1261).

The Corporation of the District of Powell River, the Powell River Regional Community Futures Society, the Powell River Chamber of Commerce and the Regional District of Powell River sent written submissions to the Commission. The Nanaimo Natural Gas Pipeline Committee and the City of Nanaimo made presentations at the regional hearing in Nanaimo. All of the above presentations echoed the argument that the community will benefit from the construction of the pipeline. The areas could look forward to expanding small business activity providing employment and increasing the tax base. The latter would provide community services benefitting local area residents (Exhibit 42).

4.2.2 Conclusion

The construction activities would generate short-term demand for goods and services in communities along the pipeline route. Employment would be stimulated in areas touched by the line and in the province generally. The resulting property tax revenues would provide benefits to local Governments for the life of the project.

4.3 Environmental Considerations

4.3.1 Fisheries (Freshwater and Marine)

There are in excess of 162 streams and rivers to be crossed by the pipeline, many of which are highly valued for commercial and sports fishery purposes. Several which have important salmonid enhancement facilities located on them and several are licensed for domestic or agricultural use.

The greatest concern with respect to fisheries is from sedimentation of streams as a result of pipeline construction or during the operations of the project. The construction activity, either in the stream or where the pipeline runs parallel to a stream, could cause sedimentation and potential destruction of fish habitat. During operations the fish habitat could be disturbed by slope failures or debris torrents in unstable areas of the pipeline. A risk also exists if emergency work has to be carried out at some future time in, or adjacent to, streams. Finally, there is a lack of specific fish habitat information in the Application which makes it difficult to assess whether there will be a loss of productive capacity of this resource.

The DFO has responsibility for the maintenance of the fish habitat under the authority of the Fisheries Act. The DFO indicated at the hearing that it expects to have a close working relationship with PCEC. Furthermore, PCEC is committed to either flume sensitive fisheries stream crossings or to construct only during approved timing windows (subject to approval) and to abide by marine blasting restrictions at the five proposed beachheads during the period November 15 to June 1. For these reasons the DFO believed the pipeline can be installed and operated without significant effects on the fisheries resource (Exhibit 62).

PCEC has noted that the Vancouver Island Gas Pipeline project traverses areas much more environmentally sensitive than areas in which its sponsor and agent, Westcoast, has normally worked in the past (T 1097). Due to this, it has recognized the need, particularly in the fisheries sector, to design and construct the pipeline with particular care and attention, as a consequence of the greater than normal environmental sensitivity (Exhibit 4).

Resulting from this recognition, PCEC has committed to undertake the preparation of a complete stream catalogue which will form part of the project's Line List. This stream catalogue will be developed in cooperation with the federal DFO and the B.C. Wildlife Federation ("BCWF"). PCEC, on numerous occasions, stated their intention to work closely with those government agencies and fully utilize their expertise, available data and judgment.

This working relationship between PCEC and the fisheries agencies will also be extended to the field surveys and construction planning for the marine beachheads. PCEC has committed to undertake appropriate marine surveys to determine habitat values, sensitivities and use, and will use this information in the preparation of a mitigation plan. This mitigation plan will include adherence to a blasting prohibition between November 15 and June 1, if required. In addition, the mitigation plan will detail the nature and extent of compensation which may be necessary to off-set unavoidable habitat destruction such as may occur from blasting, trenching and filling operations in tidal and subtidal areas.

Conclusion

The Commission views the potential impacts on the fisheries resource as the most significant of all environmental issues related to the construction of the pipeline.

The Commission recognizes the very large increase in environmental protection activity which the gas pipeline will generate and is cognizant of the limited manpower resources of both the Federal and Provincial fisheries agencies. It therefore recommends that PCEC commit the necessary financial resources to assist these agencies during the period of pipeline activity should that be required. The possible need for this support is best recognized by the degree to which PCEC is expecting support from these agencies (T 992, 1047). The limited time available to conduct and incorporate the surveys into the final design demands an exceptional degree of cooperation from all parties concerned and a full complement of personnel.

4.3.2 Wildlife

There is a general lack of specific wildlife habitat impact in the Application upon which to assess whether there will be a permanent loss of the productive capacity of the habitat for species such as ungulates and furbearers. In particular there could be disturbance to, or loss of, nesting sites for bald eagles, osprey and herons. Also there could be disturbance of wetland habitats utilized for waterfowl including rare species (trumpeter swans).

The Department of Environment was specifically concerned about the impact of the pipeline on wetlands used by migrating waterfowl and nesting sites used by raptors and osprey (T 1144). The Outdoor Recreation Council of B.C. ("ORCBC") and the BCWF also stated these same issues adding that impact on furbearers and ungulates are of concern. Each of these intervenors stated their desire for additional studies to be undertaken by PCEC to determine the nature and extent of impacts accruing from the construction of the pipeline on those wildlife species and their habitat.

PCEC has committed to avoid wetlands along the Campbell River Lateral where possible (T 1146). Nesting sites for bald eagles, osprey and herons will be identified and avoided where necessary (T 1149). The route will be re-directed in the event noise from construction (in particular, blasting) is a problem for nesting birds (T 1219). Registered trapline owners will be contacted prior to construction (T 1223). In their Application (Volume 2, Tab 7, p. 22) PCEC stated that impacts on wildlife species such as ungulates and furbearers will be low, based on preliminary information. In addition, it has been stated that construction impacts such as noise, will be minor and short-term. Longer-term impacts related to habitat alteration will be small and in some instances will result in benefits to the wildlife species (T 1221).

Conclusion

The Commission recommends that PCEC:

- Undertake surveys to determine the location, extent and value of wetlands crossed by the pipeline for waterfowl and other bird species and, in cooperation with the Canadian Wildlife Service and the Fish and Wildlife Branch, determine where such wetlands should be avoided to eliminate potential serious impacts.

- Undertake surveys to determine the location of nesting sites for eagles, osprey and herons and, in particular, in cooperation with the Fish and Wildlife Branch, determine where it is necessary to avoid such areas.

- Contact all registered trapline owners and guide-outfitters affected by the pipeline in regard to construction activities.

- Confer directly with the Fish and Wildlife Branch to determine if valuable or sensitive wildlife habitats are crossed by the pipeline and, if this is the case, undertake field assessment programs that will provide the information necessary to reduce or eliminate the impacts.

4.3.3 Agriculture

Given the location of the pipeline and facilities in the rugged terrain of the Coast Mountains and the maximization of the use of the B.C. Hydro right-of-way on Vancouver Island, the Commission is of the opinion that impacts on agriculture will be minor. In addition, it is concluded that measures which are routinely employed, and which will be followed in the construction of this pipeline as it crosses agricultural land, will alleviate any potential impacts.

However, the Commission urges PCEC to work cooperatively with the Ministry of Agriculture and Fisheries, the B.C. Agricultural Land Commission and individual farm owners during final design and construction to ensure that there is no loss in agricultural productivity resulting from the pipeline and that disruptions to farming practices are minimal and short-term.

It is noted that above-ground facilities, such as meter stations, are not currently planned to be located on land in the Agricultural Land Reserves (T 1228).

4.3.4 Forestry

The Commission notes that PCEC has developed a good working relationship with the Ministry of Forests and recommends that this continue throughout the detailed design and construction of the pipeline.

4.3.5 Parks and Outdoor Recreation

The pipeline is proposed to be located through Elk Falls Provincial Park and Rosewall Creek Provincial Park. At the southern end of Vancouver Island, the pipeline is to be routed along an abandoned railway right-of-way. Along with the ongoing visual impact resulting from right-of-way clearing, the construction of the pipeline during the summer/fall period will impact tourists and local residents using areas such as rivers, lakes and foreshores for recreational pursuits.

The central intervenor on recreation matters was the ORCBC. Their concerns were related to:

- Use of the right-of-way for access to environmentally-sensitive areas.
- The potential impact on Horne Lake Caves Provincial Park and Elk Falls Provincial Park.
- The close proximity of the pipeline to proposed Ecological Reserves.
- The potential impact of right-of-way clearing on the visual quality.
- The use of abandoned railway corridors on southern Vancouver Island for the pipeline and current plans to utilize them for trails.
- The lack of outdoor recreation inventory data in the Application.
- The potential impact on Ministry of Forests recreation sites.
- The need for public involvement by their member groups in the location and design for the pipeline.
- The need to properly assess environmental and conservation issues.
- The need for appropriate funds to be committed to ensure that government agencies properly monitor the environmental aspects of the project.

The ORCBC concluded that while many of their concerns are being met by PCEC, they wish to become a part of the environmental assessment process on a proactive basis.

PCEC has considered alternative routings to avoid Elk Falls Provincial Park, but has concluded that it is difficult to do so. Negotiations will be undertaken with the Ministry of Parks to determine a mutually satisfactory route through the Park (T 1227).

It is not believed that there will not be any significant disruption to tourism or outdoor recreation uses during pipeline construction. Construction equipment will be limited to the right-of-way and will not impose on access roads used by tourists to any significant extent (T 1228).

The right-of-way will be cleaned up and revegetated as a normal practice of pipeline construction. Where visual impacts resulting from clearing are identified, natural revegetation will be allowed to occur, thus enabling the right-of-way to blend in with the surrounding landscape (T 1225).

PCEC has committed to continuing to hold personal meetings and/or discussions with outdoor recreation user groups who express an interest in the project (Information Request 7, Tab 2).

Conclusion

The Commission believes that standard pipeline construction practices and post-construction cleanup and revegetation procedures as outlined in Volume 3 of the Application will mitigate those concerns related to potential visual impacts of the pipeline.

Due to the relatively short time over which pipeline construction will occur in any given area, the Commission is of the opinion that only minor disruptions to tourists and the general public enjoying outdoor recreation pursuits will occur. However, the Commission notes the Applicant's desire to possibly improve conditions for the enjoyment of outdoor recreation enthusiasts (T 1226) and encourages PCEC to undertake those measures wherever practical. The Commission encourages PCEC to implement their plans to consult with outdoor recreation groups and the general public in the pursuit and accomplishment of these items.

The Commission urges PCEC to conclude satisfactory negotiations with the Ministry of Parks regarding the location of the pipeline through Elk Falls and Rosewall Provincial Parks. The Commission is concerned that the visual quality of these parks not be altered by the construction of the pipeline. To this end, if PCEC is granted the right to construct through Elk Falls Provincial Park, it is recommended they utilize the existing B.C. Hydro right-of-way to the maximum extent possible and to reduce additional right-of-way clearing to the minimum required.

4.3.6 Archaeology and Heritage

The Commission notes that PCEC has committed to update their studies in regard to heritage resource impact assessments (Volume 2, Tab 5, p. 158). In addition, a commitment was made by the Applicant to implement the required mitigation measures as well as monitoring and surveillance (Volume 2, Tab 8, pp. 32-33).

The Commission recognizes the good working relationship that PCEC has developed with the Archaeology and ORCBC in this regard and is satisfied that their concerns are being correctly addressed.

4.3.7 Mineral Resources

The Commission notes that PCEC is undertaking a title search (Volume 2, Tab 5, p. 135) and is satisfied that claim holders will be contacted for specific information (Volume 2, Tab 7, p. 41).

4.4 Domestic Water Supply

4.4.1 Greater Vancouver Water District ("GVWD")

4.4.1.1 Introduction

The GVWD relies upon three watersheds as sources of drinking water supply to its system. Capilano, Seymour and Coquitlam watersheds serve the needs of 1.35 million people. Coquitlam alone supplies 40% of the water for this population and consistently provides the best water quality and lowest turbidity.

At the present time, the GVWD is opposed "on principle" to the pipeline going through the watershed based on the concern for water quality. However, if it can be demonstrated that the level of quality can be protected or the risks controlled, the GVWD may support the project (T 2274-2276). The evidence would indicate that the feasibility of the project is not in question (T 2274-2276). The GVWD witness underlined that the assessment of risk is the crux of the matter (T 2277).

PCEC proposes to construct 24 km of 273.1 mm diameter pipe through the Coquitlam watershed. An alternative alignment would have the line pass through Indian Arm, but would add approximately $19 million to the project cost (Exhibit 20, Information Request 1.1(a)). Exhibit 27 describes environmental hazards associated with the Indian Arm route and expresses the concern that "Undermining of (rock) sheeting joints may result in upslope failures being created."

The Commission must therefore assess the risk to the drinking water supply that a managed construction project through the watershed would present.

The Commission recognizes the concern of the GVWD as the alignment begins at Coquitlam Lake and follows the roadway around the east shore of the lake for 19 km. Construction on the road presents varied problems as it is very narrow and is located along a cliff that in places drops directly into the water. Beyond the end of the lake the pipeline right-of-way will provide the only access (Exhibit 64).

The road itself is 5.5 m wide, paved with gravel on crushed stone. The pipe will be buried in the roadside ditch. As bedrock lies within 300 mm of the surface, blasting will be required for 50% or more of this section (Exhibit 66).

4.4.1.2 Concerns of the GVWD

A letter was sent to PCEC by the GVWD January 31, 1989 (Exhibit 71) requesting PCEC to provide a plan outlining the construction program in detail. However, that information was still unavailable at the end of Phase II of the hearing (T 2555) and is critical to assess the apparent risk in this area. Without this material the GVWD could only speculate on PCEC construction methods. The following discussion outlines the principal concerns of the GVWD.

Turbidity

Turbidity is caused by suspended particles such as clay or silt in the water that results in a cloudy appearance (Exhibit 64) which usually occurs in November, December and January (with the advent of heavy rains) (T 2248). Coquitlam normally has a very low turbidity level (Exhibit 70) and is operated so as to dilute the turbidity level of the other two watersheds (T 2270). Nevertheless,

through the 1986/87 winter period the GVWD was able to operate without the use of the Coquitlam watershed during winter turbidity conditions in the Capilano and Seymour reservoirs (Exhibit 70).

At present, B.C. Drinking Water Quality Standards are based on the 1978 Canadian Guidelines listing 5 NTU (Nephelometric Turbidity Unit) as the appropriate turbidity level (Exhibit 64, p. 11). The GVWD has been working to a standard of 5 NTU, but this is frequently exceeded in the heavy rainfall months of October and November. The current target is to eventually attain 1 NTU (T 2158).

Turbidity itself does not present an immediate risk, but does present a problem if there are bacteria present in the system (T 2159). To control this event, chlorine is used to attack the micro-organisms. However, turbidity can shield the bacteria and make it difficult for chlorine to act (T 2179-2180), and depending on the type of material, organic or inorganic, the effect on the chlorine varies. It is generally understood that inorganic matter (such as dirt in the water) will have less effect on chlorine (T 2180-2181) than will organic material.

However, there are concerns as to the water quality if high turbidity levels coincide with the presence of Giardia contamination or other bacterial presence in the water supply. Chlorine will not be effective and bacteria will not be removed from the system (T 2157).

As the proposed pipeline crosses 17 streams and 162 tributaries, the runoff from construction could potentially result in turbid water being discharged into the lake (Exhibit 64). It is estimated that with the coincidence of rainfall, there is a three out of four chance the turbidity level would rise above 1 NTU at that time (T 2184, 2288). After approximately one to two years, the site will return to its present state (T 2282), and the risk of turbidity will naturally diminish over that time frame (T 2282). It is probable that 80% of the risk occurs during construction and 20% during the remainder of the two year period (T 2295).

Difficult Construction Project

The GVWD indicated that construction would be an onerous task with rock to be excavated or a trench to be established in bedrock (T 2194-2195). There is a potential for instability of the rock face above the trench as well as for the slopes below the road (T 2195 and Exhibit 66). Although it was ascertained that the project is geotechnically feasible (Exhibit 66, p. 10), it may be difficult to control the sediment and turbidity problem from the road runoff.

Traffic Congestion

Logging trucks currently use this access and it is thought congestion on the roadway would increase. Although logging is planned and the GVWD does achieve revenue from this operation, one solution to this problem would involve suspending that activity during the summer construction period (T 2209-2210).

Heavy Equipment

The equipment would be limited to a bending machine, two backhoes, two to three side boom tractors, two bulldozers and some drilling equipment with adequate space in the limited 25-foot roadway to deal with spoil. Discussions have been held that identified areas in the watershed where this material can be held (T 1872). It is likely that at some times the heavy equipment moving up and down the road will track mud. Even though the project is to take place in the summer months, the driest period, a summer rainstorm could cause an increase in turbidity in the lake (T 2354). The roadway is narrow and drops off directly into the water so that it is not always practical to capture the mud slurry and prevent sediment reaching the lake (T 2554).

Rainfall

The amount of precipitation is unpredictable but the records indicate that two-inch rainfalls in the summer time period are rare (one year in four) (Exhibit 70). It is difficult to construct mitigating measures to contend with large amounts of rainfall in a short period of time. However, if the weather forecasts are closely followed the construction ditch can be opened in a day and closed in the same day thereby alleviating many of these concerns (T 2226).

Speed of Construction

The speed of construction estimated by PCEC to be 2,000-3,000 ft/day was very much a concern of the GVWD (T 2239). This rate of progress was thought to be impractical in view of the limited access to the site (T 2193) and sensitivity of the watershed.

PCEC indicated that 40 men would be required for the job (spread over a very short distance) and would complete the entire project in two to four weeks (T 1868-1869). In the company's opinion, this was not a fast tracking project (T 1880) and would expect the sensitive area around the lake to be completed in about 23 days (T 2241-2242). Overall, the company suggested construction would make the same progress on the watershed road whether or not environmental conditions were imposed (T 1892).

Sanitation (Exhibit 64)

The GVWD believes the presence of a large work force in the watershed creates a difficult task of monitoring and enforcing sanitary practices to ensure human pathogens are not introduced to the water.

Petroleum (Exhibit 64)

Equipment operation requires refueling and other lubricants and coolants for operation. However, PCEC plans to have storage facilities outside the watershed and have a fueling truck make the rounds to different equipment (T 1900).

Access (Exhibit 64)

Controlling unauthorized access to the watershed is a continual concern for the GVWD. This project will open up access from the north end of the watershed which at present is not controlled and may require another gate or barrier as well as more patrols (T 2213).

Environmental Studies

PCEC identified one major stream crossing (T 1886) and nine streams that will require flumed crossings (T 1887). PCEC admitted that there is probably no way to cross a stream without producing some sediment (T 1888). Nevertheless, the GVWD's geotechnical expert testified (T 2268) that only some 10-15% of the watershed terrain through which the pipeline would pass was likely to contain colloidal material. This is a significant point as it reduces the risk of turbidity problems.

At the present time the Applicant has offered no testimony by environmental experts or other environmental evidence to establish that construction will not affect the water quality (T 2537-2541). Studies are still required to determine the streams to be crossed (T 1889), to determine whether construction of sediment basins are required (T 1890), or whether contingency plans are necessary to deal with rain-created sediment (T 1891).

Water Quality Protection Plan

The GVWD would favour a Water Quality Protection Plan to be part of the recommendation, if the Commission recommends that the Coquitlam Lake route is to be approved. The plan would deal with damage (including bonding) on terms acceptable to the GVWD under its full control, as minimum protection required for the fulfillment of GVWD obligations (T 2561). The plan would consist essentially of four parts:

- Environmental Management Program;
- Water Quality Monitoring Program;
- Water Quality and Erosion Control Program; and
- Emergency Response Program (Exhibit 64).

4.4.1.3 Commission Conclusions

In the Commission's view the GVWD quite properly takes the position that risk from activities within the watershed (as exemplified by its own logging operations) is only justified where it results in a long-term benefit to water quality. The Commission's responsibility requires it to take a much broader view of the public interest, and to weigh the benefits flowing from the construction of the Vancouver Island Gas Pipeline in relation to its full range of impacts.

The evidence is clear that a very significant financial penalty would ultimately have to be borne by the public should the Commission recommend by-passing the Coquitlam watershed and construction of the pipeline along the Indian Arm route. There are also significant environmental and social impacts associated with the latter route. The question therefore becomes one of risk management. That is, how serious are the risks to the water supply on the Coquitlam Lake route and can they be successfully managed?

From careful consideration of the GVWD concerns outlined above, the Commission concludes that the risk is acceptable and manageable. With careful construction management, under clear guidelines agreed to in advance by the GVWD, risks can be further reduced. In this respect, the Commission would have preferred that PCEC had secured a satisfactory working agreement with GVWD prior to the hearing.

The evidence of Dr. Blatherwick (T 2165) makes it clear that his water quality concerns are for the long-term impact of activity in the watershed. No evidence was adduced projecting long-term affects from properly controlled construction of the gas pipeline through the watershed. Short-term impacts are largely associated with the risks of increased turbidity resulting from relatively infrequent heavy summer rains occurring during the 23 days of mid-summer construction activity or during the short period before construction scars are satisfactorily healed by new vegetation.

With the above in mind, and acknowledging that all risks of increased turbidity cannot be eliminated entirely, it is the Commission's position that the gas pipeline should be routed through the Coquitlam Valley subject to the following specific conditions:

- PCEC shall, jointly with the GVWD, undertake studies of construction procedures and incorporate the resulting agreed requirements into construction contracts.
- PCEC shall prepare a Water Quality Protection Plan satisfactory to the GVWD, which would consider environmental management, water quality monitoring, erosion control and emergency response procedures during construction.
- Short-term costs, such as increased environmental monitoring by GVWD inspectors during construction, and the costs of constructing barriers at new watershed access points should be borne by the Applicant.
- A long-term agreement should be negotiated with the GVWD covering access and procedures involved in routine and emergency pipeline maintenance.

4.4.2 Greater Victoria Water District ("GVicWD")

The GVicWD's mandate is to provide safe drinking water for some 255,000 residents in the Greater Victoria area (T 1465). The major source of this supply is from the Sooke Lake watershed (80%) with the remainder from the Goldstream watershed (T 1467). Ownership extends to 34,000 acres of land in fee-simple but the GVicWD polices another 5,600 acres. In this capacity, it has the authority to deny access to the area by unauthorized persons and has the legal ability to pursue its policy of maintaining a closed watershed (T 1469). The GVicWD's mandate to provide high water quality can only be achieved by close control of human activity in the watershed (T 1471-1472).

The proposed pipeline crosses 7 km of the southeast corner of the GVicWD's lands called the Niagara watershed. Although this is an area not currently used as a water supply source (T 1490-1492), the proposal presents several concerns, (Exhibits 44 and 44A) as follows:

- Unauthorized Access;
- Construction Impact;
- Pipeline Security;
- Maintenance of Corridor;
- Liability Insurance;
- Flow Control in the Pipeline;
- Loss of Productive Forest Land; and
- Possibility of Second Corridor.

Conclusions

As in the case of the GVWD, the Commission recognizes that any recommendation regarding construction in a watershed must incorporate concerns for and procedures to protect water quality. Unlike the GVWD situation, the proposed pipeline does not transverse on active water catchment area in the GVicWD watershed (T 1490). The primary concern of the latter is unauthorized access of people to the watershed (T 1492). Testimony (T 1493) indicated that this has been an historical problem in that a public road runs through the watershed at Sooke Lake.

While the GVicWD did indicate all of the above concerns, they stated that the primary concern was access, and that this would "have a greater likelihood of problems with water quality because of contamination, fire and vandalism and that sort of thing." (T 1502)

The Commission believes that the Applicant is capable of satisfying the concerns of the GVicWD subject to the following conditions:

- The pipeline routing proposed through the Niagara Creek watershed should be approved.
- The Applicant should enter into an agreement with the GVicWD covering the conditions under which construction shall be conducted, and shall incorporate these procedures in the construction contracts.
- PCEC shall prepare a water quality protection plan satisfactory to the GVicWD.
- Short-term costs, such as increased environmental monitoring by GVicWD inspectors during construction, and the costs of constructing barriers at new watershed access points should be borne by the Applicant.
- A long-term agreement should be negotiated with the GVicWD concerning access and procedures involved in routine and emergency pipeline maintenance.

4.4.3 Other Water Supplies

In regard to licensed domestic and agricultural water use of streams and rivers crossed by the pipeline, PCEC has stated that all such users will be contacted. Further, they have indicated that there will be no disruption to the water quality or quantity in regard to licensed water users, and all concerns will be noted in the Line List (T 1216). The Commission is statisfied with the assurances PCEC has given regarding these other water supplies.

4.5 Environmental Protection

4.5.1 Mitigation

PCEC has indicated that the mitigation of environmental impacts has been and will further be achieved by implementing the following (Volume 2, Tab 1, p. 4):

- Selecting a routing which maximizes the use of existing utility and transportation corridors and minimizes the need for additional clearing;
- Employing the best-available expertise and techniques to design and construct the project to the highest standards;
- Undertaking further detailed studies during final design as follows:
  - The preparation of a complete stream catalogue as part of their Line List detailing construction methods and timing for in-stream work by the time a construction contract is awarded. The preparation of the stream cataglogue will incorporate all requirements of the Federal and Provincial fisheries agencies, and any future alterations to the recommended procedures will be vetted through those agencies for approval prior to construction. To this end, PCEC has hired a fisheries biologist to work on Vancouver Island with the BCFWF.
  - The undertaking of wildlife surveys to determine nesting sites for eagles and osprey (T 1152) prior to April 15, 1989 (T 1153 and 1217).
  - Herring spawning studies in the vicinity of beachheads during March 1989 (T 1196).
  - The determination, by means of assessment and mapping, of marine biological features at the five beachheads and the preparation of a mitigation plan, to be completed by the fall of 1989.
  - Environmental studies for the Crofton Lateral and the Harmac Lateral (T 2061).
  - The identification of sensitive recreation sites (T 2017).

- o Complying with the requirements of Federal, Provincial, Regional and Municipal permits, licenses and approvals;

- o Inspecting construction activities in the field, using inspection staff with environmental training and experience to enforce environmental protection measures set out in the contract documents; and

- o Providing project information to those individuals and agencies affected by the project, and implementing the measures suggested to overcome specific concerns, wherever practicable, as the project proceeds.

The Commission is of the view that, from information contained in the Application coupled with the commitments PCEC made during the hearing to undertake additional studies, the various means and techniques available for environmental impact prevention and mitigation will be fully utilized on the pipeline project. However, the Commission recommends that PCEC, in its determination of appropriate mitigation techniques, work closely with appropriate government agencies in carrying out its activities. In this manner, it is believed that cost-effective mitigative measures can be implemented that should result in a net benefit to the environment.

The proposed Project Monitoring Committee ("PMC") (see section 4.6 below) should provide assurance to the public that its interests in the employment of proper mitigation techniques and environmental protection measures, to which the Applicant subscribes, will in fact occur.

4.5.2 Budget

PCEC has noted that the areas through which the pipeline will be constructed are much more environmentally sensitive than areas Westcoast (PCEC's agent) has normally worked in the past (T 1097). This sensitivity was further noted by an intervenor during the hearings conducted in Nanaimo who urged the Commission to ensure that sufficient monies are spent on environmental protection. That view was echoed by the BCWF.

As evidenced from PCEC's response to Commission Information Request 12, Tab 2, a total of $64,000 had been spent to that time on environmental matters related to the current Application, and projected environment-related costs from the date of certification to commencement of operation are expected to exceed $1.4 million. Total costs related to environmental protection are expected to be $2.0 million.

While this figure may appear low in comparison to overall project costs (approximately 0.8%), the Commission recognizes that significant additional monies will be spent on environmental mitigation items such as aerial spans across sensitive fisheries streams and the extensive use of fluming as a stream crossing technique.

In regard to environmental protection, the Commission believes that PCEC recognizes that money spent at the outset on planned environmental protection is more effective than money spent on remedial measures at a later time, which are often more costly and less effective.

The Commission recognizes the additional load the project will place on the manpower resources of the various Government agencies, fisheries in particular, and therefore recommends financial support to these agencies as outlined in section 3.1 above.

4.5.3 Inspection

PCEC has stated its intention to hire and supervise environmental inspection staff (T 956, 986). They have indicated that the number of environmental inspectors will be between one and six, depending upon construction activities (T 1021).

The Commission views the use of environmental inspection staff as a very positive means of achieving environmental protection and urges PCEC to proceed in this manner. However, the Commission points out that there is a distinction between environmental inspection and environmental monitoring. This distinction is discussed in detail in section 4.6 below.

4.5.4 Environmental Protection Plan

An Environmental Protection Plan ("EPP") can be viewed as a means to control activities which may impact on the environment in order to avoid or lessen the magnitude and duration of the impacts. In the case of unavoidable impacts, the form of compensation required can be specified in the EPP.

For the Vancouver Island Gas Pipeline project, PCEC has indicated that the EPP will take the form of:

- Complying with all requirements of Federal, Provincial, Regional and Municipal permits, licenses and approvals;
- The preparation of a stream catalogue outlining construction practices and timing for work in and about a stream;
- The preparation of a Line List which will outline, among other things, those procedures which are to be followed by the contractor in order to avoid environmental impacts; and
- The payment of compensation for unavoidable environmental impacts.

The Commission has noted that PCEC is willing to work closely with government agencies in the preparation of the stream catalogue combined with a mapping of other environmental factors (T 1076). It is also noted that PCEC will make portions of the Line List available to those Government agencies for their review prior to being issued to the contractor (T 1014). In this manner, the Commission believes that a satisfactory EPP can be developed and utilized by PCEC and its contractors.

However, the Commission notes that PCEC is somewhat vague in regard to the nature and extent of the information that will be gathered and incorporated into an EPP (T 2049). In addition, the Commission is of the opinion that for an EPP to be effective, it must be drafted prior to construction. The statement from PCEC that the EPP will be finalized in two to six months (T 2051) is considered unsatisfactory by the Commission insofar as PCEC proposes to award construction tenders on or about April 15, 1989.

Consequently, the Commission recommends that PCEC immediately prepare an outline of the EPP and forward it for review by the PMC (see section 4.6 below) no later than April 30, 1989. In addition, the outline should state when the Plan will be completed and how it will be incorporated into the contract documents.

4.5.5 Federal Government Environmental Assessment and Review Process

The Environmental Assessment and Review Process ("EARP") applies to all projects in which there is Federal Government funding. Consequently, the Vancouver Island Gas Pipeline will be subject to this process. EMR, Office of Environmental Affairs is the agency which will administer EARP for this project.

The EMR has indicated that EARP has two phases (T 2089):

(i) Internal review of environmental impact to determine if the project may proceed as it is stated, with modifications or with terms and conditions attached, or if the project must be referred to the Minister of Environment for public hearings; and

(ii) Public hearing phase, if required.

The EARP process will be initiated when the Commission issues its report on the environmental phase of its hearing. At that time, EMR will decide which of the alternatives is acceptable. The project may proceed with terms and conditions or may be subject to federal public hearings.

The Commission is of the opinion that a federal public hearing under the auspices of EARP will not be necessary for this project because:

- The Commission has undertaken an exhaustive review of environmental matters through its public Hearing and Review process;
- Federal agencies (DFO, DOE and EMR) fully participated in this process; DFO has recorded (T 2615) that an EARP hearing is not expected to be required for their purposes. The project is relatively benign in its impacts on the environment in areas other than fisheries.
- PCEC has committed to undertaking the project with due care and attention to the environment;
- Terms and Conditions will be attached to the EPC to ensure sufficient studies are carried out and environmental protection procedures applied to the project in order to minimize or eliminate environmental impacts; and
- The preparation of an EPP and the appointment of a PMC will ensure that Terms and Conditions governing the EPC are adhered to.

In order to assist the Federal Government, the Commission pledges the assistance of its staff to the Federal agencies, wherever possible.

4.6 Project Monitoring Committee

4.6.1 General

The Terms of Reference provided by the Minister of Energy, Mines and Petroleum Resources and the Minister of Environment for the hearing of the PCEC Application requested a review and assessment of "the structure and responsibility of a PMC that would monitor the implementation of conditions, requirements and other procedures associated with project construction".

In response to a request by the Commission for its views on this matter PCEC stated that, while it was not opposed to working with a project steering committee, it was reluctant to do so due to the possibility that such a committee would only add additional time to the decision making process and would not provide a more effective method of project control. PCEC preferred to work directly with local environmental agencies' staff (T 1242). PCEC pointed to the expertise of its agent, Westcoast, in carrying out large pipeline projects throughout British Columbia. The Applicant further argued that the available information and inspection procedures were sufficient that a steering committee would not be necessary.

The Commission cannot agree with PCEC with respect to the state of preparedness of its Application for final approvals. The Applicant has repeatedly asserted that important elements of its Application are preliminary. The Commission considers that it is imperative that all environmental considerations be taken into account and that the capital costs of the project be contained and closely monitored.

In this regard, PCEC put forward argument that any increased costs prudently incurred by the Applicant should be carried over to the rate base, and thereby recovered by the Applicant. However, PCEC was not prepared to guarantee the capital cost estimates contained in its Application, as revised during the hearing (T 429).

In considering this matter the Commission notes that the great bulk of the funding of the capital costs of this project will come via loans and grants from the Federal and Provincial Governments. This creates a highly leveraged situation so that relatively modest increases in capital costs will have an exacerbating impact on rate base. The Commission will be the eventual regulator of PCEC and will have the responsibility to determine if any or all capital cost variances will be carried over to the rate base of the utility. In the Commission's normal ongoing regulation of utilities under its jurisdiction it would not allow a major project to proceed without instituting a reporting and monitoring mechanism to identify costs variances.

The Commission is also very concerned about the lack of finality with respect to many important environmental matters. These include the proposed methods of crossing many rivers and streams, the preparation of the shore approach at the south end of Texada Island, and the progress of construction activities through the Coquitlam and Victoria watersheds. To PCEC's credit, the Applicant has proposed to flume many of the river crossings where it is not certain of the salmonid resource potential. However all commitments made by the Applicant must be reconsidered as construction proceeds to ensure that environmental safeguards are maintained while construction activities are optimized to contain the projected costs.

There is also considerable merit in having a focal point for public concerns, should members of the public have difficulty in identifying the appropriate responsible governmental body to whom their immediate concerns should be addressed.

4.6.2 Recommendations

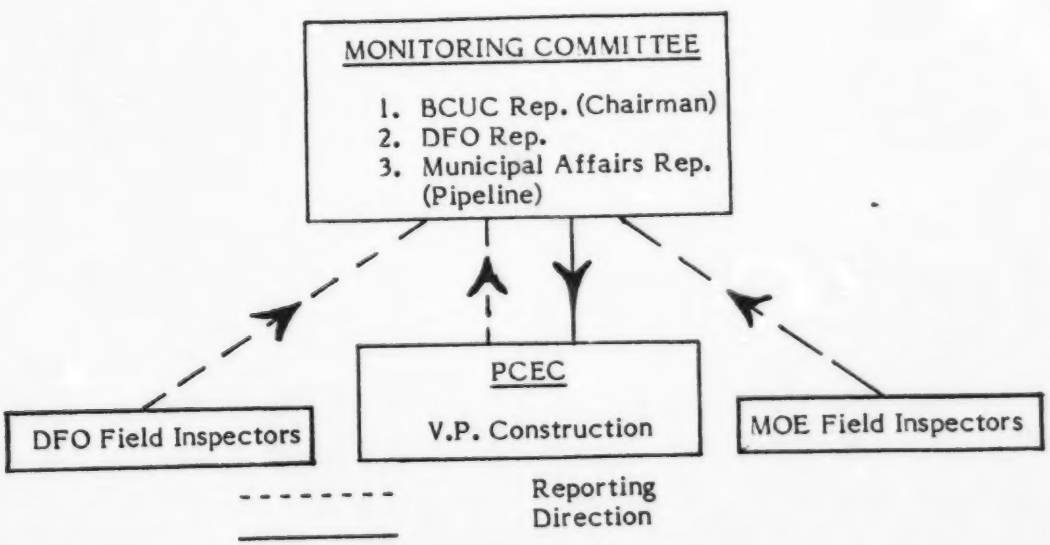
The Commission therefore believes that a Project Monitoring Committee should be established which would have the ability to require specific actions of PCEC during the construction phase of the project. It is recommended that any EPC awarded to PCEC include a condition that PCEC abide by the rulings made by the PMC. The committee must be kept to a small number of people to keep it effective and responsive. The committee's concerns should focus on the following three areas: environment and socioeconomic impacts; cost control; and safety and construction. Each of the three areas should be represented by one person on the PMC. The Commission recommends that the Chairman of the PMC be a representative from the Commission who would also take on the responsibility for cost matters of the construction program. Safety and construction matters fall within the responsibility of the Pipeline Act as administered by the Ministry of Municipal Affairs. That agency should provide a designate for the PMC. The responsible agencies for environmental matters include the Federal and Provincial Ministries of Environment, the Federal DFO and other agencies reporting within the Provincial Environment Ministry. The Commission believes that one representative on behalf of all these agencies should be recommended to sit on the PMC. That representative would have the ongoing task of liaising with all relevant environmental bodies to assist him in making representations on the PMC. The Commission believes this individual should be a representative of the DFO (refer to Figure 4.6-1).

The Commission believes that the various agencies which have been empowered by legislation to safeguard matters such as safety or fisheries should continue to administer their responsibilities. The PMC would not take action in violation of requirements made by those separate agencies. The PMC would deal with any other matters as they arise during the construction program such as compliance with EPC conditions. In the rare event that the PMC cannot agree on a required course of action by PCEC the PMC would refer such a matter to a designated Minister of the Provincial Government and a designated Minister of the Federal Government who would jointly resolve whatever action should be taken.

The Commission does not see the PMC as imposing additional cost on PCEC. Under normal circumstances the agencies involved would incur the same costs within their own organizations to carry out tasks similar to those they will perform on the PMC. The Commission therefore recommends that the proposed three PMC members be reimbursed in the normal manner through their respective Ministries.

FIGURE 4.6-1

Monitoring Committee Structure



4.6.3 Terms of Reference

In the interest of providing further clarification of its recommendations, the Commission suggests the following primary terms of reference for the PMC.

- The PMC shall act to expeditiously resolve any conflict among the various agencies involved and PCEC.
- The PMC shall establish procedures to ensure full compliance by PCEC in relation to all environmental undertakings. Any procedures should accommodate the timing constraints of the project.
- The PMC will establish financial reporting procedures by PCEC sufficient to allow the PMC to maintain cost control surveillance on a current basis and performance of construction to schedule.
- The PMC shall fix, from time to time, the numbers of field environmental inspectors (acting for the Ministry of the Environment) to be funded by PCEC. This activity shall be done in consultation with PCEC.
- The PMC shall monitor progress on the various commitments the Applicant has made and shall follow-up to ensure these commitments are met in a satisfactory and timely manner. The PMC shall further ensure that the results of any studies are satisfactorily incorporated into final design and construction.

4.7 Conclusions

The Commission is of the opinion that the Vancouver Island Gas Pipeline project will not have long-lasting, significant environmental impacts as long as environmental conditions are clearly understood and incorporated into the design and construction of the pipeline.

Those project impacts which have been identified during the course of the hearing are judged to be manageable, provided that appropriate field inspection measures are implemented and the overall performance of the project is monitored as it unfolds.

The Commission believes that the working relationship established between PCEC and the various government and public agencies will go a long way toward ensuring that the impacts are appropriately managed. The Commission wishes to encourage and foster this positive approach, particularly in light of the very tight schedule and fast-moving nature of this project.

To the end that presently unidentifiable impacts may arise during the course of the project and that matters associated with terms and conditions placed on the EPC need to be audited, the Commission has recommended that a monitoring program be implemented.

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS ON PHASES I AND II

5.1 Primary Recommendations

5.1.1 Energy Project Certificate ("EPC")

THE COMMISSION'S FINAL RECOMMENDATION ON THE AWARD OF THE EPC WILL FOLLOW COMPLETION OF PHASE III EVIDENCE.

Based on the evidence presented to Phases I and II of the public hearing which commenced on January 24, 1989, **THE COMMISSION RECOMMENDS THAT IF AN ENERGY PROJECT CERTIFICATE IS ISSUED TO PCEC FOR CONSTRUCTION OF A GAS PIPELINE TO VANCOUVER ISLAND, IT SHOULD BE SUBJECT TO THE CONDITIONS AND SPECIFIC RECOMMENDATIONS DESCRIBED IN SECTION 5.2 BELOW.**

5.1.2 Estimated Capital Cost of the Project

THE COMMISSION IS SATISFIED THAT THE PROJECT CAN BE CONSTRUCTED AT A COST VERY CLOSE TO THE $248 MILLION ESTIMATED BY THE APPLICANT. HOWEVER, IT RECOMMENDS THE ADDITION OF $7 MILLION TO THE MARINE PORTION OF THE ESTIMATE.

5.1.3 Project Monitoring Committee ("PMC")

In response to item 3(e) of the Commission's Terms of Reference (Appendix 1), **THE COMMISSION RECOMMENDS THAT A PROJECT MONITORING COMMITTEE BE ESTABLISHED AND THAT IT SHOULD BE COMPRISED OF ONE REPRESENTATIVE FROM THE FEDERAL GOVERNMENT DFO, ONE REPRESENTATIVE FROM THE PROVINCIAL GOVERNMENT MINISTRY RESPONSIBLE FOR ADMINISTRATION OF THE PIPELINE ACT AND ONE REPRESENTATIVE OF THE COMMISSION.**

The Proposed Committee structure and Terms of Reference are set out in section 4.6.3.

5.2 Conditions to be Attached to an Energy Project Certificate

5.2.1 Contractor Bids for Land Pipeline

ISSUE OF AN EPC SHOULD BE CONDITIONAL ON RECEIPT BY PCEC, ON OR ABOUT APRIL 18, 1989, OF A SATISFACTORY BID OR BIDS FOR INSTALLATION OF THE LAND PORTIONS OF THE PIPELINE WHICH, TOGETHER WITH EXISTING FIRM PIPE QUOTATIONS, ARE EQUAL TO, OR LOWER THAN, THE SUM ESTIMATED BY THE APPLICANT FOR THESE ITEMS.

The Commission notes that the above items together represent 69% of the total project cost.

5.2.2 Marine Pipeline Corrosion Protection

THE COMMISSION RECOMMENDS THAT IT BE A CONDITION OF THE EPC THAT IN ORDER TO ENSURE THE INTEGRITY OF THE CORROSION PROTECTION, AN APPROPRIATE ABRASION-RESISTANT COATING BE APPLIED TO THE FULL LENGTH OF THE EXTERIOR OF ANY MARINE PIPELINE LAID BY THE BOTTOM-TOW OR BOTTOM PULL METHODS.

5.2.3 Financial Assistance to Fisheries Protection Agencies

THE COMMISSION RECOGNIZES THE VERY LARGE INCREASE IN ENVIRONMENTAL PROTECTION ACTIVITY WHICH CONSTRUCTION OF THE GAS PIPELINE WILL GENERATE AND IS COGNIZANT OF THE LIMITED MANPOWER RESOURCES OF BOTH FEDERAL AND PROVINCIAL FISHERIES AGENCIES. IT THEREFORE RECOMMENDS THAT ISSUANCE OF AN EPC TO CONSTRUCT BE CONDITIONAL ON PCEC COMMITTING THE FUNDS

NECESSARY TO ASSIST THESE AGENCIES TO SUPPLEMENT THEIR INSPECTION MANPOWER DURING THE PERIOD OF PIPELINE ACTIVITY, TO A LEVEL SATISFACTORY TO THE PMC REFERRED TO IN SECTION 5.1.3.

5.2.4 Routing Through the Greater Vancouver Water District Watershed

The Commission has examined the proposal of PCEC to construct its natural gas pipeline through the Coquitlam watershed of the GVWD in considerable detail. It has also examined the only practicable alternative location along the east shore of Indian Arm as well as the positions of intervenors.

The GVWD's primary concern is the short-term introduction of turbidity into the reservoir during and immediately after construction of the pipeline. This topic is discussed at length in section 4.4.1 herein.

IT IS THE RECOMMENDATION OF THE COMMISSION THAT THE PIPELINE BE CONSTRUCTED THROUGH THE COQUITLAM WATERSHED BUT THAT THE EPC APPROVAL BE CONDITIONAL ON SATISFACTORY IMPLEMENTATION BY PCEC OF THE CONDITIONS LISTED IN SECTION 4.4.1.3.

5.2.5 Routing Through the Greater Victoria Water District Watershed

The proposed pipeline route passes for 7 km through the southeast corner of the GVicWD watershed. The area traversed by the pipeline does not presently form part of a water supply area. The principal concern of the GVicWD is with control of unauthorized watershed access and the possible effect of pipeline construction on this access.

From its review, outlined in section 4.4.2, the Commission is satisfied that the Applicant should be capable of meeting the GVicWD's concerns.

THE COMMISSION THEREFORE RECOMMENDS THAT THE PROPOSED GVicWD ROUTING BE RETAINED SUBJECT TO THE APPLICANT MEETING THE CONDITIONS OUTLINED IN SECTION 4.4.2.

5.3 Additional Conclusions and Recommendations on Facilities and Capital Costs

5.3.1 Land Pipeline Routing

The Commission concludes that the routing proposed for the natural gas pipeline between Coquitlam, B.C. and Victoria, B.C. is the optimum one. This is true in terms of service to market areas and in terms of minimizing the complexities of construction. **IT THEREFORE RECOMMENDS THAT THE ROUTE PROPOSED BY THE APPLICANT, SUBJECT ONLY TO MINOR LINE ADJUSTMENTS WHICH MAY BE REQUIRED FOR ENVIRONMENTAL REASONS DURING CONSTRUCTION, BE APPROVED.**

5.3.2 Pipeline Design

The Commission concludes that the use of 273.1 mm O.D. pipe at 2,160 psig operating pressure, with the Applicant's proposed arrangement of compression facilities, provides the most flexible solution to maintenance of lowest service cost over the life of the system based on PCEC's load profiles. The system includes twin lines for the main underwater crossings to enhance security.

5.3.3 Land Pipeline Construction

The Commission is satisfied, through a review of PCEC's bid package for the land pipeline segments, that essential terms and conditions necessary to ensure construction of the pipeline in an environmentally acceptable manner are in place or will be provided for in future Line Lists.

5.3.4 Pipeline Construction Schedule

The Commission concludes that the project schedule with respect to land portions of the pipeline is reasonable and achievable and allows sufficient time for the construction of an environmentally acceptable project. The schedule is designed to accommodate stream crossings during DFO approved construction windows.

The construction schedule for the marine pipeline is less certain. It must incorporate many complex marine operations and precise deepwater marine surveys. Many of these are scheduled to occur during times when weather downtime may be an important factor. In addition, rocky shore approaches must be traversed at four out of the five pipeline landings, and at each of these, extensive underwater blasting will be required. The latter activity is subject to critical fisheries windows.

After careful review of the Applicant's proposed construction schedules, the Commission concludes that, while there is a good possibility the marine portions can be completed on-schedule, **THERE IS ALSO A DEGREE OF RISK THAT, LARGELY BECAUSE OF BLASTING RELATED FISHERIES WINDOWS, COMPLETION MAY BE DELAYED BEYOND THE SEPTEMBER 1, 1990 COMPLETION TARGET DATE.** Such a delay, if it occurred, would have implications for both AFUDC and gas market development.

The importance of forestalling any risk of delay is the primary reason for the Commission's recommendations under section 5.3.9.

5.3.5 Marine Pipeline Routing

The marine routing adopted for the northern dual pipeline crossing from the north end of Texada Island to Vancouver Island is generally that proposed by Westcoast during the 1984 Vancouver Island Gas Pipeline hearing before the Commission. The dual Powell River Lateral also follows the general alignment identified at that hearing.

Preliminary marine surveys made during 1987 for the now-proposed southern Malaspina Strait crossing from the mainland to Texada Island were conducted to a level comparable to those already available for the northern crossings.

THE COMMISSION IS SATISFIED THAT THESE PRELIMINARY EXPLORATIONS ARE ADEQUATE TO ESTABLISH THE BASIC FEASIBILITY OF CONSTRUCTING A PIPELINE ALONG THE ROUTES PROPOSED, although substantial locational, geotechnical and hydraulic surveys remain to be done before precise routes can be finalized and construction commenced.

5.3.6 Marine Pipeline Construction

The Applicant has based its construction cost estimates for the marine portions of the line on the bottom-tow method, whereby pipe is made up on shore and launched by towing with deep sea tugs. **BIDS FROM QUALIFIED MARINE CONTRACTORS ON ALTERNATIVE CONSTRUCTION METHODS ARE TO BE ACCOMMODATED.**

If the bottom-tow method forms the basis of the successful tender, the Commission is concerned that the two tugs proposed by PCEC may be inadequate to pull the entire string for the longest northern crossing. Adequacy will not be determined with assurance until after pipe towing tests scheduled for August-September, 1989.

5.3.7 Manifold Location, North Texada Island

The Commission concludes that, for a number of reasons, the alternative pipeline configuration which places the manifold assembly related to the Powell River Lateral underwater should not be used. **IT RECOMMENDS THAT ALTERNATIVE CONFIGURATIONS "B" OR "C" WHICH PLACE THE MANIFOLD AND VALVING ON-SHORE SHOULD CONTINUE TO BE GIVEN PRIORITY BY PCEC.**

5.3.8 Pipeline Burial Plow

PCEC's cost estimates include $1.736 million for design, fabrication and operation of a trenching plow for pre-excavation prior to pipe burial for stabilization. **THE COMMISSION DOES NOT BELIEVE A PLOW TO BE COST-EFFECTIVE DUE TO THE EXPECTED SIGNIFICANT AMOUNTS OF ROCK IN MANY OF THE SHORE APPROACHES. INSTEAD IT RECOMMENDS ALTERNATIVE METHODS OF PIPE STABILIZATION.**

5.3.9 The Southern Texada Island Approach

Because of the inherent difficulties associated with laying a pipeline underwater on the steep rocky south Texada Island slope, the Commission favours the directionally-drilled J-tube concept for this location. Successful directional drilling of this installation would also largely eliminate one of the most time-critical elements from the marine crossing schedule.